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Application of Asphaltic Oil Through Special "Sub-Oiler" Machine, Jackson County, Missouri

SOIL STABILIZATION WORK IN JACKSON COUNTY, MISSOURI

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INCLUDED in the Jackson County highway system, exclusive of state highways, are over 300 miles of primary pavements and nearly 1,000 miles of secondary highways, mostly oiled earth. The primary system of pavements form a network covering the county so that nowhere is land within the county more than two miles from one of these highways. The paved mileage was financed with a $10,000,000 bond issue, and was completed in 1933.

Jackson County highway officials however are confronted with an ever-increasing volume of traffic and an expanding highway system. They are faced with the necessity of changing the design and location of many highways in order to more nearly conform to present-day traffic requirements, and thus furnish improved highway service. At the same time these officials have been obliged to keep within a reduced budget and yet finance a limited improvement program, maintain the county highway system, and provide for interest and other fixed bond issue charges.

The highway department, therefore, under the direction of County Engineer Alex F. Sachs and his assistant, James E. Schnittger, has become interested in improving Jackson County highways, at a reduced cost, by stabilizing subgrade soils prior to the construction of a wearing surface. One of the main objectives in the improvement program has been to develop a low cost intermediate type pavement which would not only furnish improved service to the motoring public but bring a reduced upkeep cost as well. The desire to stabilize or improve soils so as to more effectively utilize these intermediate types in their improvement program has led to some research and work of an experimental nature, and the value of asphalt as a stabilizing agent has been amply demonstrated. Three sections of road were selected during the Fall of 1934 and Spring of 1935 upon which to try out and develop some new and practical methods of soil stabilization.

The use of bituminous materials as a waterproofing or stabilizing agent was included in plans for each of the three projects. The soil on one of these roads was a fine sand, or sandy loam, one analysis showing over

80 per cent retained on a 200 mesh sieve—while on another road crushed stone had been worked into the clay subgrade during the winter and spring. The third section selected for a demonstration is known as Valley View Road, ten miles east of Kansas City and one mile north of U. S. Route 40. This latter test section for the most part lies in a valley emerging at the east end along a side hill. Subgrade soils in the valley are silty clays while along the side hill a yellow residual clay with characteristics similar to those clays along the valley predominated.

Soil Analysis.—Soils had medium to high volume changes as is indicated by shrinkage cracks in soil along the shoulder outside of the treated traveled way. See Fig. 4. This characteristic is also indicated in the analysis of several samples of soil taken prior to work, and included in the following tabulation of test results.

TEST RESULTS ON MATERIAL PASSING NO. 40 SIEVE

	35-4512	35-4508	35-4507	35-1784	35-4511	35-4510
Laboratory Number						
Lower Liquid Limit	40.8	38.5	29.5	48.9	44.3	34.8
Lower Plastic Limit	23.1	23.3	26.5	24.0	27.5	24.0
Plastic Index	17.7	15.2	3.0	24.9	16.8	10.8
Volume Change at Field Moisture Equivalent	25.7	22.1	4.5	35.9	35.7	20.4
Shrinkage Limit	14.5	14.4	22.7	12.0	13.6	17.2
Shrinkage Ratio	1.89	1.87	1.61	2.02	1.82	1.77
Field Moisture Equivalent	28.1	26.2	25.5	29.8	33.2	28.7
Moisture Equivalent (Vacuum)	36.2	33.4	29.8	53.9	36.1	31.9
Mechanical Analysis						
Per cent Passing No. 140 Sieve (Opening .104 mm)	100.0	100.0	100.0	100.0	100.0	100.0
Per cent Sand—Diameter .104 to .05 mm	10.0	12.0	11.0	10.0	3.0	11.0
Per cent Silt—Diameter .05 to .005 mm	53.0	50.0	63.0	39.0	54.0	55.0
Per cent Clay—Diameter smaller than .005 mm.	37.0	38.0	26.0	51.0	43.0	34.0
Per cent Colloids—Diameter smaller than .001 mm	21.0	22.0	10.0	27.0	19.0	13.0

Engineers of the Missouri State Highway Department advised and cooperated in the Jackson County experimental work and the soil analysis was made by the Bureau of Materials of that Department.

The principal equipment used on this work consisted of a scarifier, supply tanks for hauling bituminous material and a "sub-oiling machine" devised by H. A. Ingles of Bakersfield, Calif., together with necessary power equipment.

The Sub-Oiling Operations.—The sub-oiling machine is a tooth scarifier with the teeth carried on an "A" frame spaced approximately 2¾ in. apart, and having an oil line attached to the back of each tooth running nearly to its point. In hard or quite thoroughly compacted soils, the roadway to be treated was first scarified. The sub-oiler, pulled by a truck or light tractor,

Scarifying Old Road After Grading, Prior to Introduction of Asphaltic Oil. "Sub-Oiler" in Background

then followed down the roadway with teeth set to penetrate to a pre-determined depth. A bituminous distributor or supply tank followed along by the side of the sub-oiler and provided the necessary supply of bituminous material which was pumped through the oil lines into the soil at the rear of each scarifier tooth. After applying the asphaltic oil through the sub-oiler the road surface was leveled with a motor grader and rolled with a five ton three-wheel roller.

The theory underlying this procedure was that if a liquid asphalt be introduced at a proper depth beneath the surface of a roadway it would permeate throughout the overlying soil, thus making it water-repellent and consequently stable in uniform load supporting values.

It is believed by some engineers that with silt and clay soils, an abundance of moisture is essential in order to expedite dispersion of bituminous materials throughout the overlying soil. At any rate, general rains prior to and during work on Valley View Road wetted the soil quite thoroughly and aside from some mechanical difficulties, oiling operations were successfully carried on under conditions that would have stopped other types of highway work. According to this theory and experience, it would seem that in the Spring, just after the frost has gone, with the soil fluffed and moist, there would be offered the most favorable natural conditions for this work.

Having the proper asphaltic oil introduced to a depth of several inches, it will seep through and mix with the overlying soil. As moisture in the overlying soil

Fig. 1—Untreated Earth on Valley View Road

Fig. 2—Untreated Earth Shoulders After Spring Breakup, Valley View Road

Fig. 3—Valley View Road After Subsurface Treatment With Asphaltic Oil. Photo (Fig. 1) Was Taken Next to Bridge Shown in the Picture

evaporates it will be effectively replaced with the supply of liquid asphalt, and thus the desired results will be accomplished.

Condition of Soils After Oiling.—Whatever the reason, it is a fact that the section of Valley View Road treated early in June is now firm and stable and the asphaltic oil seems to be quite uniformly distributed throughout the soil for a depth of some 6 in. Prior to oiling these soils when wet were heavy sticky clay or gumbo type soils on which vehicles would become easily mired. They are now water-resisting and unaffected by recent rains. After prolonged dry weather the soil on the shoulders outside of the treated way became quite thoroughly dried out and large shrinkage cracks appeared. There was no indication of cracking or checking in the treated sections of roadway. On some sections of Valley View project admixtures of stone screenings, all of which passed the ¼ in. screen, were used. However, all sections of the road, whether stone screenings were added or not, are at the present time in excellent shape. By this statement it is not intended to create the impression that granular materials are not desirable materials to add to clay soils. The value of such combination has been definitely established. But the Valley View Project seems to indicate that in the absence of cheap local aggregates, clay soils can be stabilized by the proper use of liquid asphalts alone.

Amount of Asphalt and Depth of Treatment.—Liquid asphalts used on this section of road were of the SC-2 type, and were heated enough to make them flow readily (150°F.). Quantities used varied from 2 gal. per square yard to 3.8 gal. per square yard. Depth of treatment varied from 2½ to 5 in. It is thought, at the present time, that for average conditions, treatments should be from 4 in. to 6 in. in depth. Quantity and type of liquid asphalt required will vary from ½ gal. to ¾ gal. per square yard per inch depth of treatment. In extreme cases as much as 1 gal. per square yard per inch thickness may be found necessary. In some instances it will be found that MC type materials would be most satisfactory, but it is thought that the use of SC materials will be effective as a general proposition.

Fig. 4—Untreated Earth Shoulder on Valley View Road, Showing Shrinkage of Soil When Dry

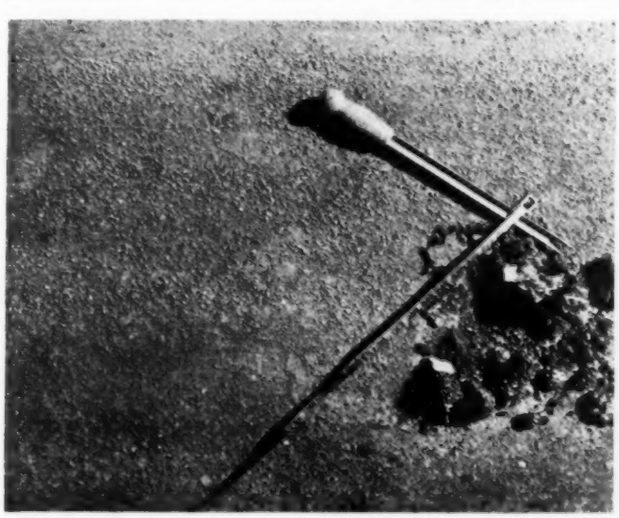

Fig. 5—Close-up of Oil Treated Surface Shown in Fig. 3

The Midwest Asphalt Materials Co. were contractors and their work was in charge of T. H. Cutler, Jr. Since completing work in Jackson County, the contractors have redesigned and built new "sub-oiling" machines that will be an improvement over equipment used on Valley View Road. This newly designed equipment will make it possible to apply a uniform horizontal layer of bituminous material beneath the surface of the roadway at any desired depth, limited only by capacity of the machine. The Missouri State Highway Department has recently entered into contracts for several miles of road stabilization work. Included in these contracts is one 10-mile project using the "sub-oiling" equipment and process. On this project, SC and MC liquid asphalts and emulsified asphalts will be used, and results will be watched with much interest.

Soil stabilization works similar to the Valley View Project have been successfully accomplished during the past by covering freshly applied oil with soil. The new process simplifies accomplishment of this type of work with more uniform results. While further improvement both in the technique of doing the work and in the selection of the most suitable materials for any particular job is certain to develop, it is felt that the engineers for the county, state highway department, and the construction organization have made a definite contribution to the science of soil stabilization as applied to highways.

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Cost of Bituminous Surface Treatment in Ottawa, Ont.

In his annual report covering the work of the Ottawa Suburban Roads Commission, Ottawa, Ont., during 1934, Alan K. Hay, Engineer of the Commission, gives the following cost data on bituminous surface treatments on several roads:

COST OF BITUMINOUS SURFACE TREATMENT PER SQUARE YARD

	North Grower Road	Richmond-Metcalfe Road	Dunrobin Road	Rockliffe Road
Miscellaneous	....	.018	.005	.001
Spraying	.008	.011	.007	.007
Sweep and Cover	.009	.029	.007	.023
Bit. Material	.032	.054	.024	.032
Cover Material	.007	.042	.006	.006
Length, miles	.64	.39	3.7	.4
Bit. Material	Tar B	Colas*	Asph	Tar B
Gal. per sq. yd.	.25	.38	.23	.25
Cover Material	Gravel	Chips	Gravel	Sand
Lbs. Cover per sq. yd.	....	.31	....	....
Total	$0.056	$0.154	$0.049	$0 069

*Two applications.

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Motor vehicle deaths in the first six months of 1935 were 2.4 per cent fewer than in the same period of 1934. If this same percentage decrease continues through all of 1935, the annual death total will be approximately 35,600 compared with 36,000 in 1934.—*National Safety Council.*

An Artistic Bridge of Corrugated Plate Arches and Concrete Spandrels

THE four-span structure here shown was built near Middletown, Ohio, by maintenance forces of the State Highway Department in the winter of 1933-1934. It carries State Route 73 across the overflow channel of the Great Miami River, which, though dry when this picture was taken, is filled at times to torrent proportions. Normal depth of this channel is 2 ft., width 100 ft.

Bridge Across Overflow Channel of Great Miami River, Near Middletown, Ohio

The bridge is designed for an H-15 loading. Each arch has a span of 19 ft. 3 in. and a rise of 6 ft. 11 in. The arch seats are 28 ft. long—wing walls 12 ft. 11 in. Arch material is 9/32 in. corrugated Armco multi plate steel.

The arch footings are 6 ft. wide and about 4 ft. deep. They are beveled at the sprining line on a plane normal to the arch ring, and are provided with 3 in. galvanized iron channels set in the concrete to hold the ring and receive the thrust.

Spandrel walls and wing walls are battered 2 in. to the foot. They are 1 ft. 9 in. wide at the top, and are reinforced in both faces. Wing wall footings are 4 ft. 8 in. wide and 2 ft. 6 in. deep. The superimposed wall bears against a 2 in. by 8 in. key in the footing.

Spandrel walls and railings are provided with ¾ in. expansion joints dividing the pylons at the center of each arch—an objectionable arrangement architecturally, in that, when seen at close range it suggests weakness at the key point of the arch, although, actually, in a structure of this type it involves no weakness at all.

The railing, post and pylon details otherwise are exceedingly attractive, and form a pleasing variation from the commoner designs. Railing width is 9 in.—post and pylon width 1 ft. 9 in. Height of railings 2 ft. 8 in. above top of spandrel wall, and 3 ft. 6 in. above road surface at curb. Roadway width between curbs is 24 ft. 7 in. There is no sidewalk.

The fill over arches is of bank run gravel, its depth at crown being 1 ft. Drainage is provided through weep holes. The road surface is an 8 in. waterbound macadam with a 2 in. surface treatment.

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When auto drivers in Memphis, Tenn., see a white cane, they had better stop until cane and owner get across the street. This is a new law. Only blind persons may carry white canes.

PERFORMANCE OF KEY EQUIPMENT USED IN HIGHWAY CONSTRUCTION

By T. C. THEE

Associate Highway Engineer, Division of Management, Bureau of Public Roads

This is the third and last of a series of performance studies of key equipment reported by Mr. T. C. Thee of the U. S. Bureau of Public Roads. The first of this series—that relating to Concrete Pavers—appeared in the August issue of ROADS AND STREETS*; the second, The Power Shovel, was given in September; the two concluding subjects—Elevating Graders and Asphaltic Concrete Mixers—are covered in the paper that follows.*

The Elevating Grader

Tables IV to IV-C, inclusive, summarize the data obtained from the studies on elevating grader operation and time losses. The jobs studied are grouped as Jobs A and B. Jobs A are the elevating grader jobs which used the 1½ cu. yd. dump wagons and the elevator belt was driven by the bull wheel. Jobs B are the elevating grader jobs studied which used tractor-drawn hauling units varying in size from 4 cu. yd. single units to 7 cu. yd. tandem units, and the elevator belt was driven by a power take-off from the tractor or by an auxiliary motor mounted on the grader.

Table IV summarized pertinent data relative to the grader operation, production, and time losses. The graders equipped with power-driven belts maintained an average plow cut of 0.9627 sq. ft. while the graders equipped with the bull-wheel driven belts averaged 0.4262 sq. ft. Larger bites could not be taken when the belt was driven by the bull wheel because it would slip if too large a bite were taken. As a result the excess tractor power was dissipated in pulling the grader at a faster speed, which is definitely shown by the fact that the average grader speed was 2.841 ft. per second on Jobs B and 3.221 ft. per second on Jobs A.

The average length of cut in which the graders operated was 346.5 and 307.6 ft. on Jobs A and B respectively.

Increased Production with Motorized Outfit.—The production obtained while the graders actually operated was 86 and 184 cu. yd. an hour respectively, even though the graders on Jobs A operated on an average in longer cuts than those on Jobs B. The use of the larger hauling units reduced the time lost due to ex-

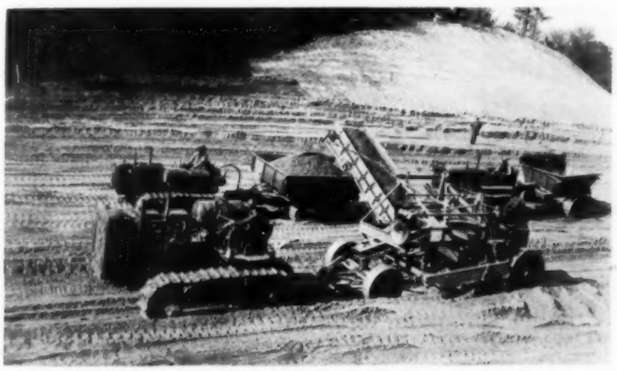


Fig. 11—*Further Improvements in the Tractor, Elevating Grader and Hauling Units During the Past Seven Years Have Resulted in Doubling Production Over the Old Type of Grader and Horse-drawn Hauling Units.* (*See Fig.* 12.)

Fig. 12—*Old Type Grader and Team Hauled Unit*

TABLE IV—SUMMARY OF ELEVATING GRADER OPERATION AND TIME LOSSES

	Jobs A Using 1½ Cu. Yd. Wagons	Jobs B Tractor Drawn Hauling Units
Total cubic yards excavated	146,241	564,733
Size of hauling units in cubic yards	1.50	7.68
Hauling unit load in cubic yards	1.1695	6.80
Area of plow cut in square feet	0.4262	0.9637
Grader speed while loading in feet per second	3.221	2.841
Grader turning time per turn in seconds	43.14	45.16
Length of cut in feet	346.5	307.6
Cubic yards per hour with minor delays	86	184
Cubic yards per hour with no delays	111	247
Cubic yards per hour with no delays, nor time lost for turning grader or exchanging hauling units at the grader	184	365

Average Grader Cycle

	Seconds			Seconds		
	Per Load	Per Cu. Yd.	Per Cent	Per Load	Per Cu. Yd.	Per Cent
Load hauling units	23.00	19.67	60.51	67.05	9.86	67.56
Exchange hauling units	7.36	6.29	19.36	11.11	1.63	11.19
Turn grader at end of loop	7.65	6.54	20.13	21.09	3.10	21.25
Total cycle	38.01	32.50	100.00	99.25	14.59	100.00

Utilization of the Available Working Time

	Hours	Per Cent	Hours	Per Cent
Load hauling units	798.88	42.67	1,546.89	46.40
Exchange hauling units	255.60	13.65	256.21	7.69
Turn grader at end of loop	265.77	14.20	486.55	14.59
Time grader operated with no delays	1,320.25	70.52	2,289.65	68.68
Minor unavoidable delays	250.41	13.38	527.76	15.83
Minor avoidable delays	138.91	7.42	256.30	7.69
Time grader operated with minor delays	1,709.57	91.32	3,073.71	92.20
Major unavoidable delays	115.06	6.15	237.15	7.11
Major avoidable delays	47.42	2.53	22.91	0.69
*Available working time	1,872.05	100.00	3,333.77	100.00

*Delays due to weather not included.

Fig. 13—Large Plow Cuts Are Made Possible Through the Use of Power Operated Belt, the 45 Horse Power Tractor Pulling the Grader and Competent Grader and Tractor Operators

changing the units at the grader and because of the fact that the power-driven belts made possible a greater plow bite resulted in the production's being more than doubled. One will find that a completely motorized elevating grader outfit today will produce approximately three times as much as a grader outfit of five and six years ago. The elevating grader output has been increased more in proportion in a shorter period of time than any key equipment, except possibly the asphaltic concrete paving plant.

Fig. 14—Hauling Unit Operators Must Be Alert in Operating the Loaded Unit Away from the Belt and Going Into Position by the Belt Quickly to Keep the Excharge Time Between Units at a Minimum

The elevating grader is a very efficient dirt mover in handling of clay and loam in level to rather heavily rolling country in new locations—particularly in those regions such as the Mississippi Valley where the soils are deep and rocks and boulders are seldom encountered. Table IV shows that over 60 per cent of the grader cycle is spent in actually excavating. A power shovel spends approximately only 40 per cent of its cycle in digging material. The elevating graders studied on Jobs A required a cycle of 32.5 seconds per cubic yard while on Jobs B the cycle time was 14.59 seconds per cubic yard.

Of the available working time the graders studied on Jobs A and B spent respectively 42.67 and 46.40 per cent excavating material and loading hauling units, 13.65 and 7.69 per cent exchanging hauling units, and 14.20 and 14.59 per cent turning the grader at the ends of the cut, or a total of 70.52 and 68.68 per cent operating at 100 per cent efficiency. The time lost due to delays was 29.48 per cent on Jobs A and 31.32 per cent on Jobs B.

Classification of Time Losses.—Table IV-A is a classification of the time losses. Delays caused by rain, wet grade, and other losses due to weather, were 15.45 and 3.29 per cent of the total study time. Motorizing the grader outfit has made a marked reduction in delays due to weather. It is obvious that this would be the case when using power-driven elevator belts and motorized hauling units.

TABLE IV-A—CLASSIFICATION OF TIME LOSSES ON ELEVATING GRADER PROJECTS

Total study time—Jobs A, 2,214.25 hours; Jobs B, 3,447.28 hours

Character	Unavoidable Delays in Per Cent		Avoidable Delays in Per Cent		Total Delays in Per Cent	
	Jobs A	Jobs B	Jobs A	Jobs B	Jobs A	Jobs B
Per Cent of the Length of the Studies Lost Due to Weather, Wet Subgrade, Etc.						
Rain	4.69	2.15	....	....		
Wet grade	4.94	1.05	....	....		
Miscellaneous	1.30	0.09	....	....		
Totals	15.45	3.29	....	....	15.45	3.29
Per cent of study time—total available working time					84.55	96.71
Per Cent of Total Available Time Lost Due to Major Delays (Delays of More Than 15 Minutes' Duration)						
Moving	1.35	0.84	0.30	....		
Tractor repair	0.53	0.12	0.03	....		
Grader repair	0.54	2.45	0.17	0.16		
Elevator repair	0.15	2.31	....	0.14		
Elevator trouble	0.11	0.93	0.07	0.03		
Rest stock	0.56	....	....	....		
Engineering	0.31	0.01	0.11	0.01		
Check grade	0.15	....	0.04	0.03		
Finishing	0.06	....	0.63	0.10		
Miscellaneous	2.39	0.45	1.18	0.22		
Totals	6.15	7.11	2.53	0.69	8.68	7.80
Per cent of available working time grader actually operated					91.32	92.20
Per Cent of the Actual Operating Time Lost Due to Minor Delays (Delays of Less Than 15 Minutes' Duration—From Stopwatch Studies)						
Deadheading	5.01	6.29	0.20	0.16		
Hauling unit supply	3.33	2.61	2.80	4.83		
Hauling unit operation	0.19	1.64	2.38	2.08		
Grader operation	0.19	0.41	0.88	0.43		
Grader repair	1.09	1.32	0.26	0.05		
Elevator trouble	1.09	1.32	0.18	0.15		
Elevator repair	0.29	0.59	0.17	0.06		
Tractor repair	0.36	0.16	....	0.02		
Tractor operation	0.06	0.09	0.09	0.08		
Moving	0.23	0.16	0.04	....		
Rest stock	0.77	....	....	....		
Rocks, roots and stumps	0.07	1.32	0.03	0.05		
Miscellaneous	1.97	1.26	1.09	0.43		
Totals	14.65	17.17	8.12	8.34	22.77	25.51
Per cent of actual operating time grader operated with no delays					77.23	74.49
Over-all efficiency of grader operation in per cent					87.63	89.13

Jobs A—1½-yard wagons used as hauling units.

Jobs B—Tractor drawn hauling units used on all except one project.

Fig. 15—Elevating Graders Lose Approximately 15 Per Cent of the Available Working Time in Turning at the Ends of the Cut; Therefore "Dead Heading" Must Be Reduced to a Minimum.

Delays due to grader repair, elevator repair, and elevator trouble increased when the belt was power-driven because of the strain on the elevating unit and especially on the belt.

The percentage of the actual operating time lost due to minor delays was 22.77 and 25.51 per cent on Jobs A and B, respectively. Dead heading, which is the unproductive time caused by the grader having to travel down one side of a cut without cutting due to the irregularity in the cross section of the cut, caused 5.01 and 6.29 per cent lost time. This lost time is considered as unavoidable and cannot be reduced, due to the fact that the grader must operate in a loop and is not designed so as to be able to shuttle back and forth without turning after making one pass down one side of the cut.

An inadequate supply of hauling units and the operation of the hauling units caused a total of 8.70 and 11.16 per cent lost time on Jobs A and B, respectively. To reduce lost time due to the suply of the hauling units to a minimum, every effort must be made by the designing engineer to keep the length of haul within as narrow a per cent variation as possible without, of course, sacrificing the utility of the final road, and the contractor must carefully advance plan the transportation so that an economical number of hauling units are used.

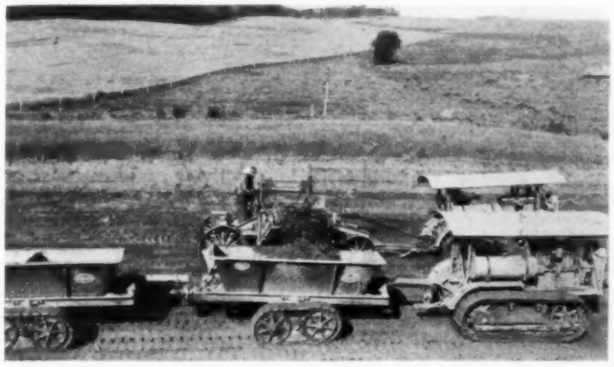


Fig. 16—Hauling Unit Operators Must Carefully Operate the Unit Alongside the Belt to Prevent Spillage, Secure a Full Load and Excharge Units Rapidly

Fig. 17—Light Trucks Have Been Used Frequently to Take Care of Longer Hauls as Well as Short Hauls Where the Soil Conditions Are Satisfactory for This Type of Hauling Unit.

Table IV-C summarizes the pertinent data relative to the graders studied. Assuming the time lost due to dead heading as part of the grader cycle, then the graders studied on Jobs B spent 62.2 per cent of this cycle in loading, 10.3 per cent in exchanging, 19.6 per cent in turning, and 7.9 per cent in deadheading. If the graders had been designed so as to shuttle back and forth without lost time due to turning or deadheading after making one pass down one side of the cut, and if a "gob-box" or hopper could have been provided to have eliminated the exchange time, a theoretical capacity of 365 cubic yards an hour would have been obtained.

TABLE IV-B—SUMMARY OF TIME LOSSES ON ELEVATING GRADER PROJECTS

Job Number	Per Cent Study Time Lost Due to Weather and Wet Subgrade	Per Cent Available Working Time Lost Due to Major Delays	Per Cent Available Working Time Grader Actually Operated	Per Cent Actual Operating Time Lost Due to Minor Delays	Per Cent Available Working Time Grader Operated with No Time Lost	Per Cent Available Working Time Grader Lost Due to Unavoidable Loss	Per Cent Available Working Time Lost Due to Avoidable Losses	Over-all Efficiency in Per Cent
Jobs A—Using 1½-Yd. Wagons								
1-A	22.61	5.69	94.31	22.38	73.20	17.35	9.45	88.57
2-B	4.61	11.39	88.61	25.60	65.92	30.97	3.11	95.50
3	23.24	5.54	94.46	18.23	77.24	9.42	13.34	85.28
4-A	16.30	11.88	88.12	22.34	68.43	21.20	10.37	86.84
5-A	14.35	8.64	91.36	25.75	67.84	17.67	14.49	82.40
6	13.11	4.45	95.55	21.51	75.00	15.18	9.82	88.42
Averages	15.45	8.68	91.32	22.77	70.53	19.52	9.95	87.63
Jobs B—Tractor Drawn Hauling Units								
1-B	7.27	3.81	96.19	27.54	69.69	23.67	6.64	91.31
2-B	1.79	7.81	92.19	27.38	66.95	29.21	3.84	94.57
3	6.64	15.69	84.31	37.48	52.71	27.69	19.60	72.90
4	1.68	10.14	89.86	28.61	64.15	29.16	6.69	90.56
5	4.01	2.92	97.08	20.11	77.55	16.60	5.85	92.99
6-C	0.00	9.09	90.91	25.67	67.58	24.11	8.31	89.05
7-C	0.00	2.72	97.28	25.40	72.58	14.91	12.51	85.29
8-C**	3.18	7.47	92.53	17.79	76.07	22.69	1.24	98.40
9	4.19	15.66	84.34	22.47	65.39	27.02	7.59	89.61
10-C	1.99	9.19	90.81	24.45	68.61	19.38	12.01	85.10
11-C	1.48	7.39	92.61	32.57	62.45	21.22	16.33	79.27
Averages	3.29	7.80	92.20	25.51	68.68	22.94	8.38	89.13

Study Time—Total length of study.
Available Working Time—Total length of study less weather, etc.
Actual Operating Time—Available working time less all major delays.
Time Grader Operated with No Time Losses—Actual operating time less all minor delays (less than 15 minutes).
**Used trucks as hauling units.

TABLE IV-C.—SUMMARY OF HOURLY PRODUCTION ON ELEVATING GRADER JOBS

Jobs A—Using 1½ Cu. Yd. Wagons

Job Number	Tractors H.P.	Grader Belt Size (Inches)	Grader Belt Power (H.P.)	Type of Hauling Unit	Hauling Unit Load in Cu. Yds.	Loading Time in Seconds	Exchange Time of Hauling Units in Seconds	Turning Time of Grader in Seconds	Area of Plow Cut (Sq. Ft.)	Grader Speed (Ft./Sec.)	Distance to Load Hauling Unit (in Feet)	Length of Cut (In Feet)	Grader Cycle Per Load (in Seconds)	Production in Cubic Yards Per Hour: While Actually Operated	No Delays	No Delays Turn or Exch	With No Delays For Given Length of Cut in Feet: 100	250	500	750	1000	Type of Material
1-A.....	60	36	B.W.	1½	1.02	24.5	7.75	47.6	0.319	3.52	86.3	566.6	38.3	74	95	150	55	80	94	100	103	Clay loess
2-B.....	60	36	P.T.O.	1½	1.00	19.7	7.40	41.2	0.508	2.70	53.1	445.3	31.1	86	116	183	80	105	117	122	125	Sandy-clay
3.....	60	42	B.W.	1½	1.055	21.0	6.60	45.7	0.388	3.50	73.5	385.8	35.1	89	108	181	67	97	114	121	125	Black clay loam
4-A.....	60	42	B.W.	1½	1.30	25.1	6.05	41.4	0.401	3.49	87.6	185.0	47.9	76	98	186	75	107	125	133	137	Clay loess
5-A.....	60	42	B.W.	1½	1.30	26.2	6.85	40.7	0.397	3.37	88.3	463.4	39.5	88	118	179	74	104	120	126	130	Clay loess
6.....	60	42	B.W.	1½	1.25	21.8	9.50	44.2	0.557	2.79	60.6	847.9	33.8	105	133	206	86	113	127	132	135	Heavy clay
Averages.....				1½	1.1695	23.0	7.36	43.14	0.4262	3.221	74.09	346.5	38.01	86	111	184	74	103	118	125	128	

Total Production on Jobs A: 146,241 Cu. Yd.

Jobs B—Tractor Drawn Hauling Units

1-B.....	60	42	P.T.O.	7-yd. tan.	11.20	152.1	22.0	45.0	0.654	3.04	462.4	228.7	242.8	121	166	265	122	170	196	207	212	Sandy-clay
2-B.....	60	42	P.T.O.	5-yd. tan.	8.40	134.9	18.8	43.9	0.614	2.74	369.6	568.2	176.2	124	171	224	108	148	189	177	182	Sandy-clay
3.....	60	42	P.T.O.	7-yd. sin.	5.00	64.9	9.2	38.8	0.845	2.46	159.8	927.5	79.2	143	228	277	148	194	215	224	228	Sandy-clay
4.....	60	42	15	7-yd. sin.	6.00	61.1	18.1	55.6	1.350	1.965	120.0	216.7	100.1	154	216	354	175	222	245	254	258	Sand & clay
5.....	60	42	20	7-yd. sin.	6.60	69.6	8.4	40.4	1.000	2.56	178.2	300.1	97.0	196	245	341	176	236	266	278	284	Sandy-clay & gravel
6-C.....	60	42	48	7-yd. tan.	11.54	111.0	14.8	38.3	0.877	3.20	355.3	475.0	148.9	207	279	374	176	245	281	296	304	Clay
7-C.....	60	42	48	7-yd. tan.	11.92	107.6	13.6	37.9	0.909	3.29	354.1	543.0	141.5	226	303	399	186	260	300	316	325	Sandy-clay
8-C.....	60	42	48	Ton-truck	2.45	17.2	4.3	34.9	1.048	3.67	63.1	516.4	25.2	288	350	512	218	303	349	368	377	Sandy-clay
9.....	65-D	32, 42	32, 48	4 & 7 yd.	5.41	47.4	9.15	42.7	1.154	2.67	126.6	209.0	76.7	197	253	411	197	265	299	313	320	Sandy-clay
10-C.....	65-C	48	36	7-yd. tan.	11.30	89.6	14.4	44.8	1.090	3.12	277.9	313.4	137.3	224	296	454	195	179	226	345	356	Sandy-clay & clay
11-C.....	65-A	48	36	7-yd. tan.	11.18	75.7	14.5	43.5	1.250	3.19	241.5	233.9	127.6	213	315	532	227	321	374	395	407	Clay
Averages.....				7.68	6.80	67.05	11.11	45.16	0.9637	2.841	190.51	307.6	99.25	184	247	365	171	235	269	282	289	

Total Production on Jobs B: 564,733 Cu. Yd.

Elevating Grader Formulas:

(1) $$t = \frac{27 \times K}{A \times S_g}$$

(2) $$D = \frac{27 \times K}{A}$$

(3) $$G = D\,(R - E') + t + E$$

(4) $$P_1 = \frac{3600 \times K}{t} \text{ or } 133.33 \times A \times S_g$$

(5) $$P_2 = \frac{3600 \times K}{D/C\,(R - E') + t + E}$$

G = Grader cycle in seconds per hauling unit load.
D = Distance in feet the grader travels to load a single or tandem hauling unit.
C = Average length of cut in feet.
R = Average Turning Time of Grader in seconds.
E = Time in seconds to exchange single hauling units or sum of exchange times for tandems.
E′ = E when single hauling units are used and E/2 when tandems are loaded by grader.
t = Total time in seconds to load single or tandem hauling unit.
S_g = Speed of the grader in feet per second while loading.
K = Average size of load in cubic yards hauled by single or tandem hauling unit.
P_1 = Cubic yards per hour if no time were lost due to exchanging, turning or delays.
P_2 = Cubic yards per hour if no time were lost due to delays.
A = Cross-sectional area of plow cut in square feet.

The new 48-in. belt graders equipped with a 50 h.p. auxiliary motor, if similarly designed, would have a theoretical capacity of approximately 550 cu. yd. an hour. This points out the development that can still be made to increase the production of the elevating grader.

The effect of the length of cut on the hourly production is shown in Table IV-C. The possible production of the graders studied on Jobs B, assuming no delays, varied from 171 cu. yd. an hour in a 100-ft. cut to 269 c. yd. an hour in a 500-ft. cut. This points out the need for the engineer to utilize this fact in designing the job and the need for the contractor to carefully study this feature of the job to determine the maximum possible production of the grader.

The size of the hauling unit determines the distance the grader has to travel in loading the hauling unit. The economical length of cut is one equal to or in increments of the distance the grader travels to load a hauling unit.

Using the larger 65 H.P. tractor with a 48-in. belt grader equipped with a 50 H.P. auxiliary engine, the area of the plow cut will average in good material over 1.25 sq. ft. with the grader speed maintained at a rate of 3.0 to 3.25 ft. per second.

If the required number of hauling units are available for the given length of haul and for the output of the grader, 5-yd. singles can be exchanged in 6 seconds and 7-yd. singles in about 9 seconds. If the 5- or 7-yd. units are operating in tandem there is a double exchange time involved, between the individual units in the tandem and between the tandem units. The total double exchange time for the 5-yd. tandem units is about 13 seconds, and the double exchange time for the 7-yd. tandem units is about 14 seconds.

The grader can be turned at the end of the loop consistently within 40 seconds if the tractor operator is experienced. Even keeping the turning time at this figure the percentage of time lost due to turning the grader when using the large hauling units amounts to about 45 per cent in a 100-ft. cut, 25 per cent in a 250-ft. cut, almost 15 per cent in a 500-ft. cut, and about 8 per cent in a 1,000-ft. cut.

One must consider the elevating grader as an excavating machine and the hauling supply as a means of hauling the material excavated; it is therefore necessary to have the proper coordination of at least three distinct divisions: (1) the material must be dug and loaded into the hauling units at or near the maximum rate of production for the material handled and for the given length of cut; (2) the distance the earth must be hauled, and (3) the hauling unit supply which must be provided in order to move this production over this distance.

Fig. 18—*The Use of the Power Shovel and Elevating Grader Combination Has Proven Economical in the Middle West, Particularly in Minnesota and Wisconsin*

The Asphaltic Concrete Mixer

Considerable progress has been made in reducing the cost of the asphaltic type of road construction on the West Coast. This is, in part, due to the fact that equipment companies following suggestions of engineers and contractors have improved and enlarged the paving plants to such an extent that batches weighing 4,000 and 5,000 lb. can be handled as readily as formerly those weighing only 2,000 or 3,000 lb. They have also redesigned the pugmills to increase the efficiency of the mixing, which, after confirmation by mixing time studies, has led to a reduction of the mixing time. The general adoption and use of the finishing machine and spreader-box has also played a part in this progress. And last but not least in this movement has been the work of the contractors in detecting and reducing the numerous costly minor delays by the use of the stop-watch and in synchronizing and coordinating the various dependent operations.

Tables V and V-A are the results of studies made of a 5,000-lb. asphaltic concrete pugmill mixer on the West Coast.

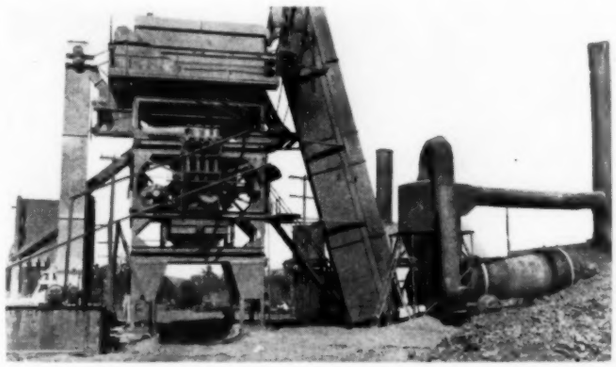


Fig. 19—*Asphalt Plants Used on Western Road Construction Have Been Improved and Enlarged to Such an Extent That Batches Weighing* 4,000 *and* 5,000 *Lbs. Can Be Handled as Readily as Formerly Those Weighing Only* 2,000 *Lbs. Electrically Controlled* 5,000 *Lb. Plant Shown Above*

TABLE V—SUMMARY OF ASPHALTIC CONCRETE MIXER OPERATION AND TIME LOSSES

Total tons of asphaltic concrete mixed	29,296.47
Total batches asphaltic concrete mixed	11,140.00
Average batch size in tons	2.64
Batches per hour with no delays	72.13
Tons per hour with no delays	189.69
Batches per hour with minor time losses	57.40
Tons per hour with minor time losses	150.96

Average Mixer Cycle

	Seconds		
	Batch	Per Ton	Per Cent
Charge mixer	4.60	1.75	9.24
Mix concrete	38.80	14.76	77.74
Discharge	6.50	2.47	13.02
Total cycle	49.91	18.98	100.00

Utilization of the Available Working Time

	Hours	Per Cent
Charge mixer	14.27	4.01
Mix concrete	120.06	33.75
Discharge	20.11	5.65
Time mixer operated with no delay	154.44	43.41
Minor unavoidable delays	6.83	1.92
Minor avoidable delays	32.80	9.22
Time mixer operated with minor delays	194.07	54.55
Major unavoidable delays	153.82	43.24
Major avoidable delays	7.86	2.21
*Available working time	355.75	100.00

*Delays due to weather not included.

A number of studies have been made of the key equipment used on asphaltic concrete paving jobs; however, only the results of one job are given to contrast the development made as the studies were made of so many different sized pugmills that time would not permit presentation of all these data.

During the study 29,296.47 tons of asphaltic concrete for all courses, or 11,140 batches averaging 2.64 tons each, were placed. The mixer had a capacity, for the given mixing time which averaged 42.05 seconds including half of the discharge time, of 72.13 batches or 189.69 tons an hour. During the actual operating time when no major delays occurred 57.40 batches or 150.96 tons of material were mixed an hour.

The average mixer cycle for all material mixed was 49.91 seconds per batch and 18.98 seconds per ton. The time required to charge the pugmill with all the materials was 4.61 seconds; 38.80 seconds were required for mixing, and 6.50 seconds to discharge the concrete into the "gob-box" holding three batches. During the mixer cycle 9.24 per cent was spent in charging the mixer with materials, 77.74 per cent in mixing, and 13.02 per cent in discharging the pugmill.

The percentage of the available working time spent in the operation of the mixer was 43.41, or 4.01 per cent to charge the mixer, 33.75 per cent for mixing, and 5.65 per cent to discharge. Delays and time losses were 56.59 per cent, with minor delays 11.14 per cent and major delays of 45.45 per cent of the available working time.

Table V-A is a summary of the time losses which occurred. Delays caused by rain and wet subgrade were 3.32 per cent of the total study time. Mechanical trouble with the mixer and lack of material were the largest major delays. The asphalt plant was new and equipped with automatic controls and timing device and therefore a number of adjustments had to be made, which delayed operations.

The capacity of the only feasible source of rock was not sufficient to meet the requirements of the plant and this caused considerable delay.

An inadequate supply of hauling units caused the largest minor delay all due to poor planning of the superintendent. The total minor delays were 20.42 per cent of the actual operating time. Shortage of hauling units was 70 per cent of the total minor delays.

Even with so many delays occurring, the potential capacity of the asphalt plant was so large that the actual production maintained was one of the highest obtained. The bid price on this work was $3.07 per ton and the contractor finished the job with a substantial profit.

TABLE V-A—CLASSIFICATION OF TIME LOSSES ON A 5,000-LB. PUG-MILL ASPHALTIC CONCRETE JOB

Total study time.....368.00 hours

Time Lost Due to Weather and Wet Subgrade, Etc.

Character	Unavoidable Delays Hours	Unavoidable Delays Per Cent	Avoidable Delays Hours	Avoidable Delays Per Cent	Total Delays Hours	Total Delays Per Cent
Rain	4.25	1.15	....	....		
Wet subgrade	8.00	2.17	....	....		
Totals	12.25	3.32	....	....	12.25	3.32
Available working time					355.75	96.68
Major Delays Occurring During Available Working Time (Delays of More Than Fifteen Minutes' Duration)						
Hauling supply	....	....	7.86	2.21		
Mixer (mechanical)	69.96	19.67	....	....		
Material handling	1.39	0.39	....	....		
Lack of material	68.00	19.11	....	....		
Moving and street oper.	6.47	1.82	....	....		
Miscellaneons	8.00	2.25	....	....		
Totals	153.82	43.24	7.86	2.21	161.68	45.45
Time mixer actually operated					194.07	54.55
Minor Delays Occurring During Time Mixer Actually Operated (Delays of less than fifteen minutes—from stopwatch studies)						
Hauling supply	....	....	27.89	14.37		
Hauling operation	....	....	0.06	0.03		
Batcher bins empty	2.33	1.20	2.33	1.20		
Mixer operator	....	....	2.48	1.28		
Mixer, mechanical	3.92	2.02	....	....		
Asphalt pump	0.10	0.05	....	....		
Elevators	0.40	0.21	....	....		
Batcher trouble (mech.)	0.04	0.02	....	....		
Miscellaneous	0.04	0.02	0.04	0.02		
Totals	6.83	3.52	32.80	16.90	39.63	20.42
Time mixer operated at 100% efficiency					154.44	79.58
Total of all avoidable delays (Class B delays), hrs.					40.66	
Possible operating time—Class B delays eliminated, hrs.					195.10	
Efficiency of mixer operation, per cent					79.16	

Conclusions

A larger number of contractors, engineers and equipment manufacturers are making time studies of key equipment as well as of the auxiliary equipment, because they are finding such studies invaluable in disclosing pertinent data by which many problems in the manufacturing of highways can be solved. In these times contractors have found that management research has been the only solution to the problem of staying in business, realizing whatever affects the output per unit of time affects the unit cost.

Road Maintenance Truck Equipped With Sprinkler Unit

One of the most dangerous hazards to traffic on untreated gravel highways is the clouds of dust raised by moving vehicles. The Washington State Highway Department is doing its bit towards minimizing this hazard by equipping its road maintaining units with dust laying apparatus. The first step consisted of equipping one of the department's Four Wheel Drive road maintenance trucks with an underbody spray unit. The water supply is carried in an 850-gal. tank mounted on the truck frame and an even flow of water is assured to the underbody spray bar by means of a small power pump.

Right Side View of Road Maintenance Unit Showing Water Tank and the Underbody Spray Unit

The idea for this installation was first conceived in July, 1934, and through the efforts of L. V. Murrow, State Director of the Department; Norman Hill, Distrit Engineer, and Percy Stanley, Master Mechanic of the Spokane District, it was put into service in June, 1935, on Pend O'Reille Highway between Spokane and the Canadian border.

The FWD maintenance unit travels 146 miles per day and uses less than four tanks of water. It requires only three to four minutes to refill the tank.

FOREIGN PRACTICES IN BRIDGE FOUNDATIONS

Some Items Relating to Sheet Piling and Coffer Dam Construction

INTERESTING features in the construction of pier and abutment foundation in England, Holland, and Canada are described in the August first issue of our London Contemporary, Roads and Road Construction. Because a comparison with practice in this country will be of interest to many American engineers, the article from the British paper is quoted in full below:

Bridge foundation work is always more or less of a difficult nature. It is necessary to go down, often to considerable depths, to find a firm bearing strata for the piers and abutments, whilst in the former and sometimes in the latter, there is an appreciable flow of water to be resisted, and the rise of abnormal floods due to unforeseen conditions. In deep water there is usually no alternative to the caisson and cylinder systems, but in relatively shallow depths, the modern conception of an old principle, the cofferdam, enables foundations to be got in satisfactorily under conditions which would have been impossible, but for the introduction of modern piling systems.

This exceedingly useful material originated many years ago in the I-beam and inter-locking member which, in the particular form shown is the Universal Joist Sheet Steel Piling of the British Steel Piling Co. It has the advantages of long life and high salvage value. It can be used a large number of times and re-sold after completion of the work for 30-60 per cent of its original cost. The standard flange width is 5 in., and with several depths available, any desired space may be made up without the use of specials, and all joists have the same "clutch" or interlocking member. This form of pile with its symmetrical section and centre line always coincident with its centre of gravity, drives and pulls easily and requires but little bracing. It can be employed in a structure after the temporary work is completed and the clutches used as reinforcement.

The clearance between joist and clutch whilst allowing of easy driving is watertight without caulking other than by means of a few ashes thrown into the water, which

Fig. 1—Typical Joist Piling

will be drawn into any leaky places and seal them. Corner piles can be supplied bent to any angle, junctions and crosses are formed by riveting other joists on one or both sides of the pile for running an intermediate line across the cofferdam if this be required. Fish plates are provided when it is necessary to drive the piles in short lengths or to remove the top lengths after driving; the joists are usually staggered by one or two feet, the bolts provided with square necks and the outer fish plates with square holes in order to facilitate the unscrewing of the nuts.

Whilst from the above description it will be concluded that this form of piling would—in the majority of instances—serve the present purpose exceedingly well, certain conditions are sometimes better met by the more recently introduced U-shaped or Larssen pile. It is designed for the specific purpose of constructing permanent retaining walls capable of withstanding high pressures. Its light weight renders it economical for this

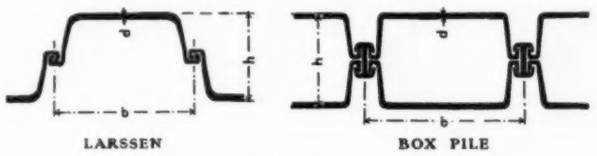


Fig. 2—Typical Larssen Piling

purpose, whilst the distribution of the material in the trough section provides the maximum strength with the minimum weight. There are available fourteen different sections of this pile in which the interlock consists of a dovetail joint as shown with a very small clearance but of sufficient accuracy and straightness to make jointing and driving quite easy, and it is virtually self-sealing. The union box section is designed for cases where exceptional rigidity and ability to withstand shock are called for. Here two trough-shaped sections are joined by means of a clutch similar to that employed with the U-J piling, and a connecting bar can be used for joining to Larssen sections. A special wedge-shaped clutch is used for circular work.

Some Typical Applications

The general application of steel piling to the construction of bridge piers is shown in the accompanying drawing which gives a section of the piers of a large structure comprising 185 ft. x 23 ft. truss spans on mass concrete piers with a 375-ft. swing span where flood and tide conditions rendered the work difficult. By the use of steel sheet piling for the outside of the permanent structure, the walls thus formed completed an efficient protection for the rest pier of the swing span in a very economical manner.

Heavy flood conditions called for a strong and efficient guard to this span taking the form of a pier 430 ft. long and of varying width, being maximum at the centre with 44 ft. For this structure No. 2 Larssen piling was used in lengths averaging some 67½ ft. With a timber crib set and anchored in position, a standard Larssen corner pile was driven to form the nose pile and, thereafter, driving proceeded down the two curved sides of the streamlined nose (formed with standard straight piles) and along the diaphragm wall end. Junction piles specially riveted, were used at the two corners from which the two long side walls of the pier were started. The piles forming these were placed and driven

in a similar manner against timber cribs resting on the excavated river bottom, every other pile only being driven into the clay, the alternate ones finishing 5 ft. below low water level.

In forming the centre caisson, 70-ft. piles were pitched in the same way, the crib supporting them having its centre section constructed of steel joists which were later concreted in the pier. The projecting ends of these beams were afterwards cut off so as to isolate the main pier from the steel guard walls. After the piles had been driven to their penetration of 15 ft. below the dredged level, the entire crib was raised a distance of 15

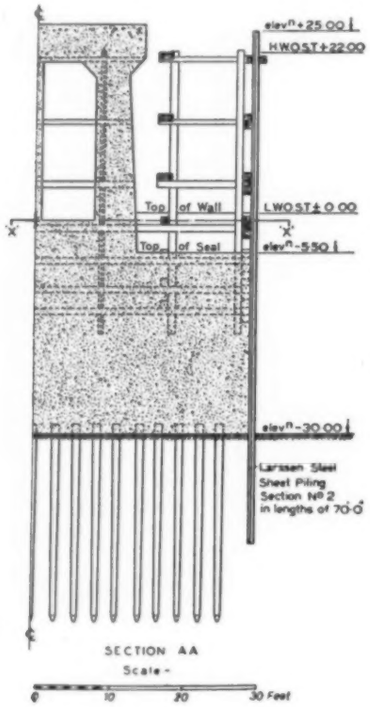


Fig. 3—Coffer-dam on Saguenay Bridge

ft. by winches so that the concrete for the base of the pier might be placed directly against the piling after the timber bearing piles had been driven under water. This proved a good test for the Larssen piling, since but little clearance was available on any side. Capped with an 8 in. x 16 in. timber coping strake and coated with tar, the final appearance of this pile-formed pier proved quite good.

Use of Box Piles

In the foundations of the Koninginne Bridge, Rotterdam, the parallel-sided, semi-circular-ended cofferdams 57.2 m. long x 18 m. wide, were formed mainly of No. 3, 32 m. Larssen sections, but here additional strength was secured by using one box pile section to every nine piles. They are only used in the side walls. In forming these cofferdams, a steel bracing frame of the same size was built on shore in the form of upper frames separated and held in position by timber struts. This was towed on pontoons to the site of the pier and lowered into the water. Another frame was then added to carry the piling frames and hammers so that they functioned as templates as well as bracing for the completed cofferdam. All the box sections were driven first, after which the Larssen piling was placed between them and driven in groups. With every other lock of this piling pressed and by driving it in this way the surrounding walls were closed without resort to special taper piles.

On completion of the cofferdam, ferro-concrete piles for the pier foundations were driven inside it before unwatering and on the top of these the pier was formed of mass concrete. After completion of the concrete foundation, the piling was braced to the pier walls by timber props and the steel struts removed: thereafter the steel piling was cut flush with the river sill.

A Difficult Job

In the case of the Richlieu River Bridge, Sorel, Quebec, the river is both wide and deep, and it is, in addition, subject to those sudden rises of flood water which add so much to the difficulties of this class of work. The very poor nature of the subsoil which consists of very soft sandy clay here, necessitated piled foundations for five of the piers. Four of these are located in the river, the foundation levels being up to 40 ft. below mean water level. The material was dredged away over the site of each of the main piers leaving the river bed at a flat slope commencing a few feet outside the circumference of the pier. They are carried on a large number of 40-ft. timber bearing piles driven by means of a double-acting steam hammer operating under water. This hammer worked between heavy timber telescopic "leaders" suspended from a floating derrick. Meanwhile, two bracing frames of timber and steel were assembled on the river bank in the form of a crib, the latter being launched into the river from skids floated to the side of the pier. The frames were 76 ft. 4 in. x 33 ft. overall, their ends being semi-circular in plan to correspond with the minimum dimensions required inside the steel piling. Section No. 2 in lengths of 61 ft. Larssen piling was then assembled round the frame and driven to 15 ft. below excavation level. This was carried out two piles at a time, the tops being protected by cast steel driving caps, the aforementioned frames acting both as templates and as bracing. The subsequent construction of the piers proceeded in the dry with 28 feet of water against the piling outside. With the pier built up to the underside of a frame, the dam was flooded, the whole bracing floating up to permit of further construction, the piling being the while strutted off the new work. The material in the cribs was thus salved without difficulty, cutting or waste.

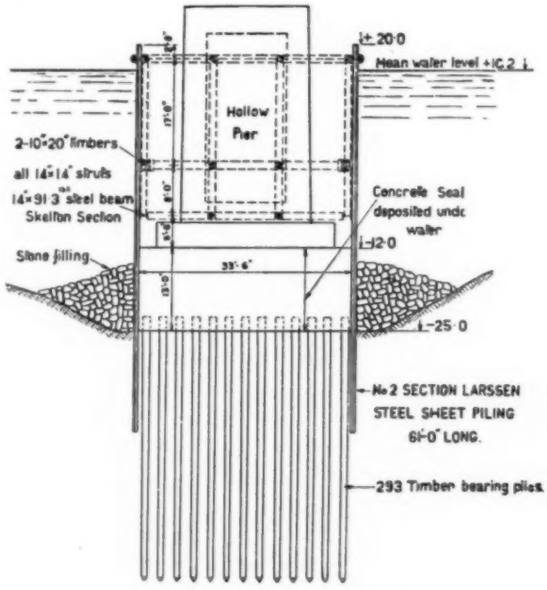


Fig. 4—Richlieu Bridge, Quebec

WINTER MAINTENANCE ACROSS THE CONTINENT

These pictures of snow removal operations from Maryland to British Columbia supplement views shown in the September issue of Roads and Streets.

In Wisconsin, Where Snow Is Snow. A Caterpillar Diesel Seventy-five Tractor with Wausau V-Type Plow Opening Things Up in Polk County, February 22, 1935

On Long Island, N. Y., in the Winter of 1934-1935. Model 35 Diesel Cletrac Propelling a Sargent Plow in the Town of Babylon

A Rough Job in California Mountains. The Equipment—a Le Tourneau Angledozer Propelled by an A-C Model L Tractor

Clearing an Intersection in the Boro of Kennett Square, Pennsylvania, January 28, 1935. A Chevrolet Truck Equipped with a Good Roads Model 16-D Champion Plow and Blackhawk Lift

Rural New England No Longer Stays Snow Bound. Here the Road Is Being Opened with a Frink V Type Plow Mounted on an FWD Truck

In Northern Wisconsin last January. With Two Feet of Snow and the Thermometer Nine Below Zero, Motorists Were Eager to Follow the Snow Clearing Unit Which Is Seen Heading the Procession at the Right

The View at the Left Shows the Same Unit—an Austin-Western Dual Drive "77" Motor Grader Equipped with V Type Plow and Snow Blade—Making a Second Trip

Widening Out a State Highway in Maryland. An FWD Truck Behind a Sargent V Type Plow

Lewiston, Maine Does a Thorough Job. A Caterpillar Diesel Auto Patrol Equipped with Caterpillar V-Type Plow Clearing a Street on April 5, 1935. After Snow Was Disposed of, the Scarifier Was Used to Remove Ice

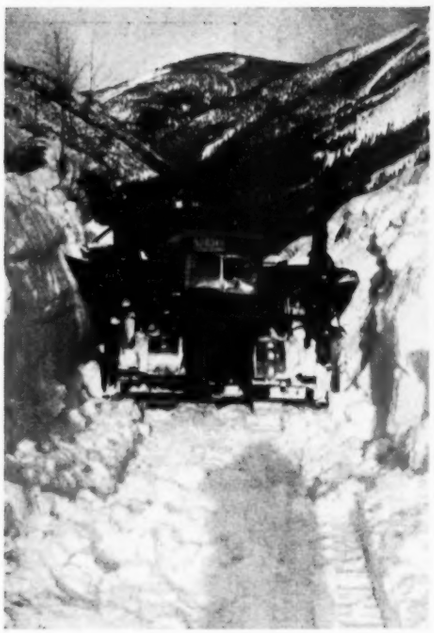
On U. S. Route 6 at Joliet, Illinois. A Bates "80" Tractor Equipped with Sargent Plow

Naches Highway Crosses the Cascade Mountains Via Chinook Pass at a High Altitude. Here We See a Snow King Rotary Plow and an FWD Truck Clearing the Pass for the Washington State Highway Department

Sidewalks Are as Important as Roads. A J. I. Case Model "CI" Tractor and Snow Plow at Racine, Wis., December, 1932

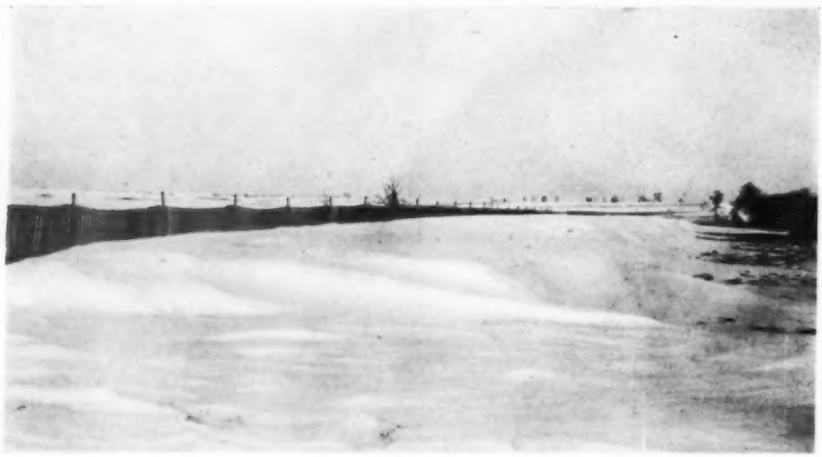
On a Mountain Highway in the State of Washington. Snogo Rotary Propelled by Truck Cutting Through High Drifts

Clearing Up Under the Trees with a Burch Corporation Ross One-Way Plow



In British Columbia, February, 1935. *A Baker Model* 45 *Tractor Snow Plow Breaking Through a Six-Foot Snowdrift at Nelson*

In Fond du Lac County, Wisconsin, March 11, 1935. *Opening Road with a Wausau V-Type Plow and an Allis-Chalmers* 50-*Horsepower Tractor*



Snow Fence and Its Effects. Views Taken After a Storm in March, 1932

Above: On U. S. Route 30, East of Rochelle, Illinois. At Right: On Illinois Route 27, Northwest of Dixon

An American Plow Opens the Road for Tourists and Winter Sportsmen in the Alps. A Rotary Snow King Model 906 Cutting Through Eight Feet of Hard, Party Rained-in Snow in Julier Pass, February, 1934

LIMITED STREET BUDGET BENEFITS LARGE PART OF COMMUNITY

By EDWARD CAMPBELL

Commissioner of Public Works, Floral Park, N. Y.

FLORAL PARK, a suburban village of 11,000 population, is situated on Long Island, N. Y., close to the New York City line. The street system of the community embraces approximately 25 miles, a considerable mileage to maintain in satisfactory condition with the small budget provided in these times.

However, as the result of a careful survey of the cost and effectiveness of various types of street surfacing, supplemented by experimental work on the village streets, a satisfactory solution has been worked out. At the beginning of 1934, the greater part of our street surfacing consisted of tar macadam and untreated or oiled earth streets. In previous years, it has been the policy of the village to expend a large part of the available funds in the construction of a comparatively small yardage of high-priced paving. This policy was altered in 1934, when it was decided to lay a surface, which, while adequate for the amount of traffic served, would

Floral Parkway, an Example of the Use of Carpeting Asphalt Over an Old Tar Macadam Surface

be sufficiently low in cost to permit an extensive program.

As a result, the following procedure has been adopted: All streets in the village, whether oil treated earth, worn macadam or worn concrete will receive two applications of a cutback or carpeting asphalt, each treatment being covered with ⅝ in. stone, embedded in the asphalt through the use of a 5-ton roller. The asphaltic material, which contains approximately 85 per cent of asphalt, is applied at the rate of ⅓ gal. per square yard for each treatment. The second application may be put down later the same year or during the year following the first application. Dolomite stone is used for covering, spread at the rate of approximately 20 lb. to the square yard.

In the case of untreated earth streets, it is necessary before reaching the carpeting asphalt stage to prepare the surface by two preliminary applications of asphaltic oil, the product used in Floral Park having an asphalt content of approximately 55 per cent. If necessary, the earth surface is scarified, then shaped, after which the oil is applied at the rate of 5/10 gal. per square yard. A covering of sand is spread over the oil and

Casting ⅝ Inch Cover Stone Over Application of Carpeting Asphalt

the resulting surface dragged frequently for a period of two weeks. About six weeks later, the second application of oil is put down, at the rate of 3/10 gal. per square yard, the procedure being the same as in the case of the first application. Later the same year, or the following year, the street is ready for the first treatment with carpeting asphalt.

According to our plan, carpeting asphalt and stone cover are spread 18 ft. wide on the street, leaving a space 3 to 5 ft. wide from where the asphalt leaves off to the curb on either side of the street. These shoulders are being brought to grade and crown and treated with an asphaltic oil following the method described above for oiling untreated earth streets.

Our street program gives employment to 20 men,

Beverly Avenue, an Instance of the Use of Carpeting Asphalt Over an Old Broken Concrete Road

Vanderbilt Avenue, the Center of Which Has Been Given the Carpeting Asphalt Treatment. Note Amount of Traffic Using This Street

formerly engaged in almost as many different kinds of work. Excellent results are obtained with such unskilled labor. The only mechanical equipment required consists of a five ton tandem roller, a 1½ ton truck and a rotary broom. We estimate that the cost of one coat of carpeting asphalt, 18 ft. wide, covered with stone, is approximately what it cost formerly to maintain a mile of worn macadam surface.

Prior to 1934, it required two months' work in the spring to patch the village streets and put them in condition for summer traffic. As a result of having carpeted with asphalt approximately 11 miles of streets last year, it was necessary this past spring to spend only two weeks in patch work. An additional 7 miles of streets received the carpeting with asphalt during the current year.

Except for the application of the Texaco asphaltic material, which was put down by the Andrews Road & Supply Company of Mineola, N. Y., all of the work was done by the village forces.

An Earth Shrinkage Diagram for Office Use

By WILLIAM SELL

THE accompanying diagram for earth shrinkage will be found convenient for highway engineers. It is well known that more than 100 cu. yd. of cut are required to make 100 cu. yd. of compacted earth fill, and that a shallow cut apparently shrinks more than a deep one. If, between two "balance points," the cut per 100 ft. station is C, one formula for the required excess cut over fill is $p = 40 - .27\ C$. For example, if in 600 ft. there is a cut of 360 double end areas (18,000 cu. ft.), C is 360/6 = 60, and $p = 40 - .27 \times 60 = 23.8$ per cent, say 24 per cent. This excavated earth will make a fill of 360/124 per cent = 290 end areas.

The diagram is to be used with a straight edge. For the above example, lay the straight edge on "Sum of End Areas" = 360, and on "Length of Balance" = 6. It will cross the "Per Cent" scale at a little below 24.

Cuts heavier than 100 end areas per station are assumed to have a shrinkage of 13 per cent.

For any other formula in which the shrinkage depends only on the average amount of cut per station, the middle scale may be recalibrated by the user. Set the straight edge on any assumed values of "Sum" and "Length." Where it crosses the "Per Cent" scale, make a mark and label it with its proper value according to the other formula. As many such points are made and labeled as are required.

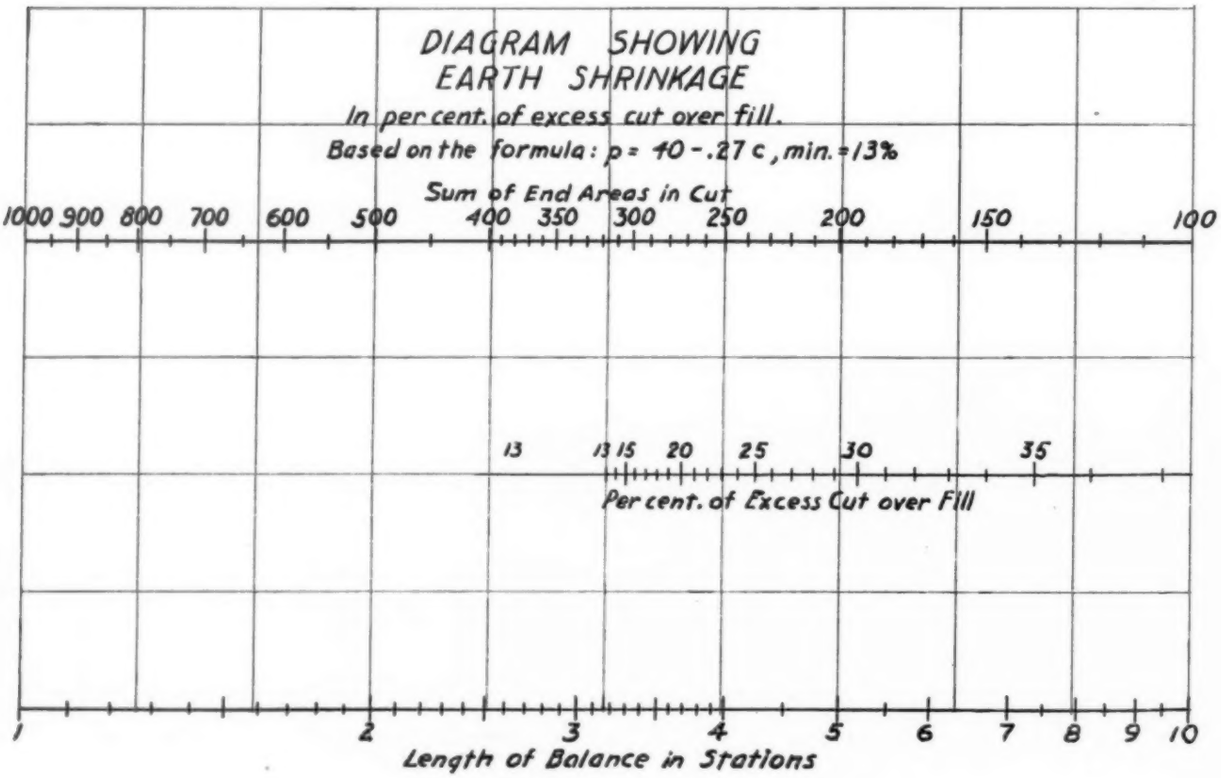
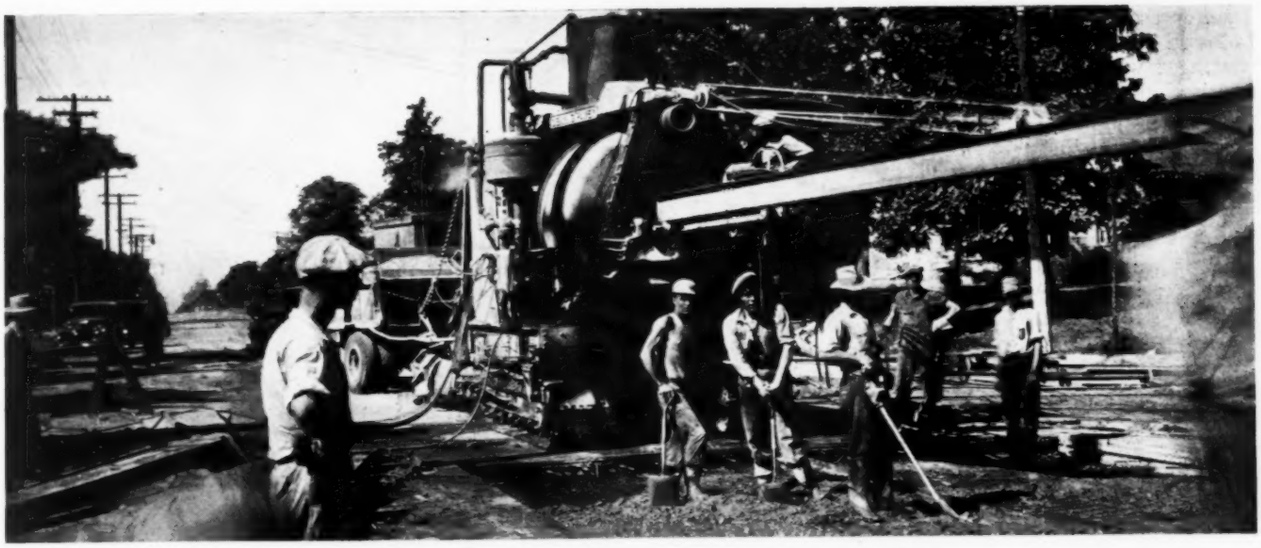


DIAGRAM SHOWING
EARTH SHRINKAGE
In per cent. of excess cut over fill.
Based on the formula: p = 40 - .27 c, min. = 13%
Sum of End Areas in Cut
1000 900 800 700 600 500 400 350 300 250 200 150 100
13 13 15 20 25 30 35
Per cent. of Excess Cut over Fill
1 2 3 4 5 6 7 8 9 10
Length of Balance in Stations

Diagram for Earth Shrinkage



The Vibrator Was Operated by a Small Generator on the Paver

VIBRATION AND POWER SUB-GRADER FEATURE PEORIA JOB

IN completing the first project in Peoria's newly adopted Major Street Program (See ROADS AND STREETS, August, 1935), the same pioneering was shown in construction methods as was employed in effecting the plan.

Feature of the work included the use of internal vibration in compacting the concrete at joints and edges of the slab. A power subgrade planer was also used on the job.

One of the most needed projects in Peoria was Jefferson St., which is expected to carry 70 per cent of the through north and south city traffic, as well as out of town vehicles on state route 29.

The Plan called for a 6-lane street with four 10-ft. lanes and two 8-ft. parking lanes. With the traffic estimated, an 8-in. uniform concrete slab was adequate, analysis showed.

Power Subgrader Prepares Surface.—The old surface was removed with a gas shovel and rough grading was done with a power excavator. After the subgrade was rolled, a power subgrade planer was pulled along, neatly trimming to an accurate 8-in. depth.

Power Subgrade Planer Being Unloaded from Truck

The planer rides the regular pavement side forms and is pulled by a tractor. Knives on the front side trim the subgrade. On the rear of the machine are tampers which compact the prepared surface. This power planer is made by the R. B. Equipment Co. of Royal Oak, Mich. A scratch template showed excellent results with the power planer.

Vibrator Used.—A rigid handle Type U-F-E-I Vibro-Spade vibrator powered with V-I power plant was used to compact the concrete around joints and at edges of the slab. The 21E Koehring paver was equipped with a small generator to operate the vibrator. The power cable was carried along the boom, clearing the workmen spreading the concrete.

After the finishing machine, a longitudinal float was followed by transverse float and straight edge. The pavement was then belted, broomed and covered with wet burlap for 24 hours. Calcium chloride was used for final curing.

While a stiff mix was used, no trouble was experienced in finishing the slab. The vibrator added appreciably to the quality of the work at the joints. Ace type joints were used, and no honeycombing was to be found.

Joints were extended through curbs, contraction and expansion joints being alternated. Curbs were tied to the slab with tie bars.

Before the slab was placed all underground work was done. Drainage was provided with 18, 12 and 10-in. concrete pipe. Manholes were constructed to stay level with pavement surface, being set with flange, into the pavement.

Conduits for future street and traffic lights were placed the entire length of the pavement, and were laid through intersections, driveways and sidewalks.

At intersections, where the Major Street Plan calls for future widening, the intersection was built accordingly with reverse curves which narrowed down to the present 30 ft. width of pavement. High early strength cement was used at two major intersections to permit early opening of the pavement to traffic.

Routing of Paver Speeded Work.—Routing of the paver resulted in completion in the minimum time, the least interruption to traffic, and the greatest economy to the contractor. Traveling south, the two west lanes were placed, skipping intersections. At the south end the paver crossed over and paved the two east lanes. Again the paver crossed to the west side, traveling on the cured slab, and placed intersections the width of two lanes. Then down the center, placing the two remaining 10-ft. lanes, and finally back the east side on the cured slab, completing intersections.

The present improvement is 7,861 ft. long. It was financed out of the city's share of the refund from the Motor Fuel Tax, without assessments.

Construction of the improvement was under the direction of Leonard D. Jeffries, City Engineer. Hartmann and Clark Bros. were contractors.

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POST GRADUATE HIGHWAY ENGINEERING EDUCATION IN GREAT BRITAIN.—The Chair of Highway Engineering at the Imperial College of Science and Technology at the University of London is the only one in the British Empire devoted solely to the subject of highway engineering. The main work of the Department is intended for post-graduate students and engineers requiring "refresher" course. In this category the average number of students attending each year, since the foundation of the chair in 1929, has been only six; and in 1932-33 the number was as low as four.

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Job Kinks for Cement Bound Macadam

With growth of interest in cement bound macadam, an interest in edge bars, center tie bars and dowels has been shown. Some difficulty was anticipated, but surprising simple ways have been found to make such installations.

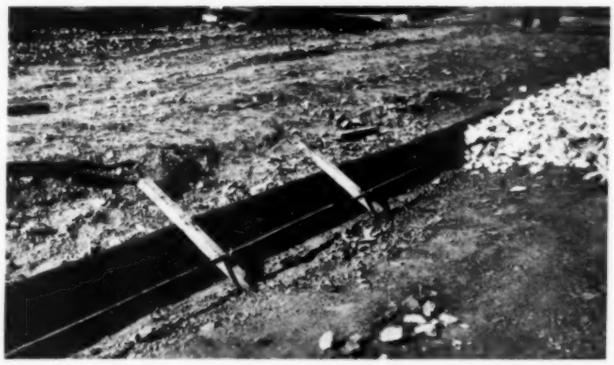
A simple method for installing edge bars is to rest grade stakes along the form as shown in an accompanying illustration. To position the bars, a nail is driven in the upper face of the stakes. To hold the stakes in position, a second nail is driven in the under face at the outer edge of the form.

When stone is spread it rolls under the bar without disturbing it. To level it off flush with the form some hand forking is necessary. When the stone is in place and before compacting, the stakes are given a quarter turn and withdrawn.

Dowels are placed by trenching the stone out with forks after it has been spread. They are then put in position and the stone raked back in place.

Center tie bars may be shoved through the loose stone after one lane has been spread. If the bars are shoved well into the loose stone it facilitates spreading of the stone in the second lane. The tie bars then may be readily pulled back the proper distance in the loose stone of the second lane.

The labor required for all of these operations is simple and involves little expense when they are used.



Installing Edge Bar. Nails Position the Stake and Edge Bars. After Stone Is Placed Stakes Are Easily Withdrawn by Giving Quarter Turn, Freeing Nail from Bar and Pulling

Installing Dowel Bar. Trenches Are Dug for Expansion Joints and Dowels, Which Then May Be Easily Installed

Installing Center Tie Bar. After Stone Is Spread in One Lane, Tie Bars Are Shoved Through, Leaving About 6 In. of Bar Extending Into the Unfilled Lane. After Stone Is Spread Into the Unfilled Lane, Tie Bars May Be Centered Easily by Hand Before Compaction

PROPOSED TRUCKING REGULATIONS IN GERMANY

Regular Hauling Under Fifty Kilometers Remains Unrestricted — National Railway Appears Loser in Effort to Control Long Haul

A voluntary report to U. S. Bureau of Foreign and Domestic Commerce by Assistant Trade Commissioner Rolland Welch, Berlin, Germany.

Following the lines of the German law effective March 16, regulating passenger traffic in motor vehicles, a law is now proposed in Germany which will regulate the transportation of merchandise by automotive vehicles.

This law is said to be before the Reichskanzler awaiting his signature. Full details of it are not yet available, but it is similar to the act regulating passenger motor vehicles and it represents a departure from previous ideas and a total defeat of the German National Railway Company in its desire to control goods transportation on highways. The proposed new law will appear to be decidedly for the "little fellow," but, although the German National Railway does not get what it has been demanding, there is a joker in the proposed act which may still enable railway officials to dictate to a great extent the regulations which are to balance the competition between railway and highway carriers.

The Railway Company, up to the present moment, has been demanding what amounts to a monopoly on the highway traffic of merchandise, in that it has requested the authority to operate all highway goods traffic by having the exclusive right to collect and distribute cargoes to the various truck operators while guaranteeing them a certain load and mileage per day. Heretofore, the Government has appeared to lean toward the National Railway Company, which it owns, but on the surface the proposed new act pictures Chancellor Hitler as favoring the "forgotten man" against the Railway Company.

The new act probably will provide first of all for the cancellation of all licenses of all truck men or companies that are not operating on a regular schedule between fixed points. This means that the trucking licenses of practically everybody in Germany will be cancelled, because most trucks here are operated when and where cargoes are available. That is to say, approximately 70 trucks enter Berlin from various points each day, but there is rarely enough cargo available here to enable them to operate a regular schedule out of Berlin. The "spediteurs" in Germany collect the cargo at various stations in the cities, and when the trucks arrive they call at these stations begging for whatever cargo exists, ready to leave at any time, in any direction.

This means, then, that new licenses will have to be acquired by all truck operators carrying goods for any firm or person under tariffs. It will not apply to firms operating their own fleets.

The new licenses will be granted by the head of the city or province involved, on a basis of "necessity." It is said that practically all of those now having licenses will be able to renew them.

The second main proposal is that all operators of trucks, whenever they are given a license by the proper authority, must then join a union or association. Since none can operate a truck without a license and since everybody holding a license must belong to this association, it is obvious that the Government intends to control them. This association will be a semi-governmental body with great authority. It is to elect a president, the election to be approved by the Government Traffic Minister, who may, if he feels it necessary, appoint a president of the association. In any event a representative of the Traffic Minister will attend all meetings of the governing board of this association.

This governing board is to fix tariffs in cooperation with the Railway Company. The Railway Company is not given any seat on the board, even though it also is an operator of highway trucks. In the event the Railway Company and the union cannot agree upon a tariff, the Minister of Traffic has the power to establish a tariff and to make it effective. Heretofore there has been a tariff agreement between the Railway Company and the operators of trucks, but these numerous truck operators have often engaged in the practice of secret tariff cutting. The proposed new law provides heavy penalties for any truck operator cutting tariffs in any way or giving any kind of prize or remuneration to the shipper. It also provides that the shipper is not to accept any special or cut rates, gifts, prizes, or bribes. The association itself will collect all money paid for shipments and distribute it to the transporters. In this way the association will be able to control the regulations against special reduced tariffs. Heavy penalties are attached to this provision, and the violators, including shipper, "spediteur," or carrier, are liable to punishment.

The entire act applies only to operators of trucks over distances of more than 50 kilometers. Transporters of goods over distances under 50 kilometers are not forced to be members of the association, and they may operate just about as freely as they desire.

A battle probably will take place when the truck operators and officials of the railroad sit down to establish a tariff schedule. In Germany there are about six different classes of merchandise, each paying a different freight rate. That is to say, perishable merchandise pays a higher freight rate than unperishable goods, such as coal, usually shipped in bulk. At present, the law provides that operators of trucks must charge freight in any one of the three highest tariff classifications. This makes it impossible for them to carry unperishable goods in bulk. It is understood that they will demand the right to carry goods in cheaper tariff classifications.

Although the truck operators seem to be delighted with the prospect for the new law, they forget that the Railway Company is federally owned and is operated just about as the Traffic Minister desires, and that they too are now about to be operated as he chooses, and that he undoubtedly has no intention of favoring them to the great financial disadvantage of his Railway Company.

It is expected that this law will be signed and put into effect within a few months, although within that time it may undergo some changes in writing. It is also important to notice that this act is based on the new German "leadership principle," which is another way of saying that absolute control will really be placed with Chancellor Hitler.

Rational System of Testing Bituminous Materials Urged

AT A MEETING of the Asphalt Industry held at the Waldorf-Astoria Hotel, New York, Sept. 12, 1935, Mr. Thomas H. MacDonald stressed the three following points:

The very extensive use of bituminous materials in the highway program of the nation necessitates the development of dependable and rational means of determining quality of these bituminous products and their adaptability to the several uses for which they are specified. He considers the present situation as leading to the dependence of state highway departments upon tests to determine origin or source rather than quality, since, in the absence of a rational system of testing and specifications, the states are seeking to obtain their bituminous materials from sources which have most generally provided suitable products. He stated that this method will, of course, have the effect of eliminating many products which could be used to advantage, and the further effect of limiting the sources of supply whereas if rational tests and specifications were developed all bituminous materials suitable for the purpose desired would be admitted. He warned the industry that this is a problem demanding solution and calling for the fullest measure of cooperation on the part of the industry, and that a policy of passive acceptance of present conditions must inevitably lead to efforts outside of the industry to solve the problem. He therefore urged that the industry unitedly cooperate with scientific and governmental agencies.

Mr. MacDonald dwelt very forcefully upon the relationship of the secondary highway program to the petroleum industry as a whole, and pointed out a definite connection between the trend of the highway program and the growth of the gasoline tax. He stated that already property has been relieved of the burden of improving the main highways and is rapidly being relieved of the burden of secondary road improvement through the imposition of gasoline taxes, and it becomes a matter of genuine concern to the petroleum industry to insure a program of secondary road improvement which will involve a tax burden of reasonable proportions rather than one of staggering size.

He pointed out that a very large mileage of secondary highways, if constructed without regard to that degree of permanence which would insure low maintenance costs, might impose such vast requirements for maintenance money as to necessitate excessively high gasoline taxes, particularly if the trend toward the relief of property taxes should continue as at present.

Specifically, his contention was that there should be—first, an economically sound selection of the secondary roads for improvement, and, second, that they should be improved with a view to providing a type of all weather highway, largely accomplished by the intelligent use of bituminous materials, so that the maintenance costs would remain within moderate figures. He very aptly cited the amazing influence of the pneumatic tire in the design and conservation of our public highway, and told of the early conferences at which the claim was confidently made that trucks and buses could not be provided with adequate pneumatic tires. The Bureau of Public Roads believed the problem could be worked out. That it was worked out successfully through the cooperation of the Rubber Association of America is a matter of history. Mr. MacDonald contends that with the cooperation of the petroleum industry this problem of a rational secondary highway program can be worked out with equal success.

Mr. MacDonald stressed the enormous field of subgrade stabilization for all types of highway and for unsurfaced highways as offering not only an almost limitless market to the asphalt industry, but as calling for an extensive and thoroughly coordinated program of research in which the industry would cooperate with scientific and governmental agencies. He cited the characteristics of various soils to indicate the complexity of the problem, but appeared confident that complete success would follow such a program. He called attention to the fact that the potentialities in the requirements of bituminous materials for subgrade stabilization render this field practically as important from a commercial standpoint as the highway field itself. He cited the fact that other industries are already active in the development of methods of subgrade stabilization, notably the calcium chloride industry, the salt industry, the Glutrin industry and the cotton textile industry, and that the asphalt industry could not fail to be intensely concerned in this vast potential market.

In concluding his remarks Mr. MacDonald referred to research work which has been proposed by the Highway Research Board as a cooperative project with the asphalt industry and involving the cooperation of the U. S. Bureau of Public Roads and state highway departments, and urged that consideration be given to the desirability of such research. He stated that as indicating the regard in which the work of the Highway Research Board is held by the Government, the U. S. Bureau of Public Roads contributes $20,000 a year to the work of the Board.

Mr. MacDonald answered a number of questions and touched upon many specific problems as developed in the questions.

His address was followed with close attention by a very representative gathering of asphalt and petroleum executives including among others Mr. Axtell Byles, the President of the American Petroleum Institute; Mr. W. S. S. Rodgers, the President of the Texas Company; Mr. C. S. Sheffield, the Vice-President of the Standard Oil Company of New Jersey; Mr. Paul Blazer, the President of the Ashland Refining Company; Mr. A. M. Maxwell, Vice-President of the Standard Oil Company of Ohio; Mr. C. W. Bayliss, Vice-President of Barber Asphalt Company; Mr. W. W. McFarland, Vice-President of Warner-Quinlan Company, and others.

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Motor-Vehicle Registration and Taxes

A total of 24,933,403 motor vehicles were registered in the United States in 1934, according to statistics compiled by the U. S. Bureau of Public Roads from reports of state authorities. The total registration in 1933 was 23,843,591. The increase in 1934 was 4.6 per cent or 1,089,812 vehicles. Of the 1934 registration, 21,524,-068 were passenger motor vehicles and 3,409,335 were freight motor vehicles.

The total receipts received by the states from motor vehicles, including registration fees, miscellaneous receipts of motor vehicle department, and special taxes imposed on motor carriers, were $312,929,000.

Widening with Tar Penetration Macadam

TAR TREATMENT OF OLD ROADS TO PREVENT SKIDDING

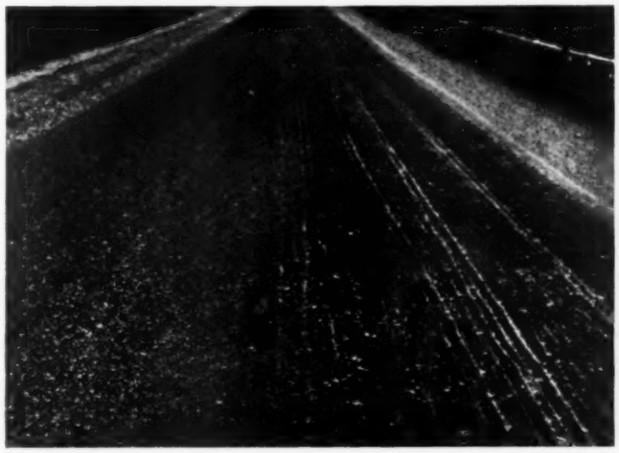
By C. H. OLMSTEAD
Consulting Engineer, The Barrett Company

IN the design and construction of new pavements, our highway engineers have been constantly improving the safety of our highways. Sight distances have been greatly lengthened where possible, both vertically and horizontally, and where not possible, surfaced widths are being increased to a four lane highway. Curves have been eased and given more super-elevation. Skid proof surfaces have been given much attention as the next important step in making our highways safer. There is still, however, a great problem confronting the highway engineer in the making of old, but still serviceable highways, less dangerous. Each year this problem becomes increasingly important, with not only the great increase in automobiles and trucks, but the increasing speeds of these vehicles. We also have a large increase in the yearly mileage of the individual car and truck.

Most of these old highways are of the penetration macadam or bituminous concrete type. Curves were of more frequent occurrence and with a much higher degree of curvature than those of later design. Grades were heavier and vertical curves were much shorter, with short and hazardous sight distances.

Outside of Curve on Route 41, North of Cullman, Ala., Treated with Tar to Prevent Skidding

Many skidding accidents occur on straight sections of highways that are slippery, when wet, and a large percentage occurs when there is the necessity of slowing up due to approaching bridges, railway grade crossings, intersections and sharp vertical curves. In approaching these hazardous points the driver many times senses



Surface Scarifying and Tar Gravel on Outer Half of Curve, Route 41, Maury County, Tennessee

them suddenly and quickly applies the brakes. If the pavement is slippery and wet, brakes not in perfect adjustment or wheels not in alignment at the time the brakes are applied, the tendency to skid is great.

In approaching a short sharp vertical curve, with short sight distance, a driver not familiar with the road may be going quite fast. As he tops the vertical curve and sees a steep grade on the other side, he will naturally try to slow up quickly with a possible skidding accident. Several such conditions have come under the writer's observation on old penetration macadam highways. Skidding accidents were so frequent at these points as to require a remedy. A light application of tar was made over the vertical curves and covered with

stone chips. Accidents due to skidding were eliminated from that time on at these points.

In many cases of old highways, the horizontal curves were sharp, lightly banked or not super-elevated at all. With these curves slippery, skidding very frequently occurs. This danger can be materially reduced by giving the outside half of the curve an application of tar, covered with clean chips. In the event that increased super-elevation of the curve is desired, and in most instances this is the case, a premix of tar concrete using a graded aggregate, a road mix or several tar surface treatments can be placed on the outside half of the curve, making the outside half skid safe, and affording traffic moving at much higher speeds than were prevalent when the old highway was constructed, a safer surface.

The different appearance of the rougher texture of the more recently surfaced outside half of the pavement, calls the attention of the vehicle driver to this condition, and it is surprising to notice how the traffic tends to keep to the right side of the curve, instead of cutting in to the inside of the curve.

On sharp horizontal curves it is often possible to widen the pavement on the inside of the curve providing a wider surface around the most dangerous portion of the curve. This improvement can be made by constructing a base of any available local road material, tar penetration macadam, or tar premix followed by a skid safe surfacing of tar, using either a tar premix or tar surface treatment.

Many of our old highways were constructed with high crowns and having narrow widths. Today in practically all states, the minimum widths on all state highways is 20 feet. These old highways can be widened by using any of the standard methods and raising the widening sections to reduce the excessive crown. Excellent skid safe edges can be made by excavating the widening section to the required depth and constructing the base as previously described. A tar premix or road mix can be used for the surface of the extra width, reducing the excessive crown by extending the surface part way over the old surface, thinning it out as it approaches the center to provide a skid safe surface for the outer wheels of the car.

There have been cases where attempts have been made to increase the skid resistance of old bituminous surfaces by making longitudinal cuttings with heavy steel discs. This has not proven satisfactory and usually results in damage to the surface by cutting through the protecting seal coat and starting raveling of the aggregate.

Outside of Curve on Route 41 *South of Columbia, Tenn., Treated with Tar for Prevention of Skidding*

Surface Cut with Steel Discs to Stop Skidding; Later Outside Half of Curve Surfaced with Tar and Gravel; Route 41, *Maury County, Tennessee*

All grades of tar, when properly used, greatly improve the skid resistance of slippery highways. For light surface treatments the grades of cold surface treatment tar can be used, with a light application of uniformly distributed coarse sand, fine chips or pea gravel for cover, using only sufficient cover to keep the tar, when fresh, from picking up under traffic.

For the heavier treatments, heavier tar should be used, preferably a hot surface treatment tar, using a medium size chip of stone, slag, crushed gravel or pea gravel. These heavier treatments will require from two-tenths to one-third of a gallon of tar per square yard. An excess of covering material should not be used, and if used, should be removed by brooming, after the surface has been rolled. Excessive chips allowed to remain on the road surface under traffic are an excellent abrasive, grinding the aggregate embedded in the tar, which is later removed from the surface by traffic, wind or water, carrying the tar with it and damaging the surface.

For the road mix and premix a heavy retread tar, hot surface treatment tar, or cold patching tar can be satisfactorily used with a graded aggregate.

Where funds are not available to make old slippery highways skid-safe with a complete tar surface treatment, a great reduction in skidding accidents can be accomplished by a careful study of the driving hazards of the road and an expenditure of only a few hundred dollars, to make the hazardous sections of the road skid safe with tar.

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Tar Mastic Cushion Course Mixed in Transit.—An interesting construction feature of the recently completed brick pavement on Penn Ave. in Wilkensburg, Pa., was the methods used in preparing the tar mastic for the bed or cushion course. The sand and tar accurately proportioned were transported and thoroughly combined in a transit mixer while enroute from the loading point to the site of construction. The pavement is 36 ft. wide and consists of 3 in. fiber lug vitrified brick on a tar mastic bed with a concrete base.

Highway Research Board Meets in December.—The 15th annual meeting of the Highway Research Board of the National Research Council will be held in Washington, D. C., on Dec. 5 and 6, 1935. R. W. Crum, 2101 Constitution Ave., Washington, D. C., is director of the Highway Research Board.

KEEPING ROADS OPEN IN WINTER

A Paper Presented at the 1935 Conference on Road Construction at Toronto

By ALAN K. HAY
Engineer, Ottawa Suburban Roads Commission, Ottawa, Ont.

By F. E. WEIR
County Engineer of Lincoln, St. Catharines, Ont.

Discussion

ON winter roads, snow removal should be preceded by some measure of snow control. Most of our newly constructed roads help the situation in this respect because grades are being built wider, ditches have a flatter cross-section, wire fences replace log-fences and brush and other obstructions are eliminated.

Brush Cutting Important.—Good summer maintenance assists in keeping things this way and should always be carried out with snow-drifting in view. It is surprising at times to see a very considerable drift formed because some small patch of brush was left uncut along the fence line.

Snow Fencing.—In open country, where drifting is known to cover the road, the customary form of protection is the erection of portable lath-type fencing on steel posts or pickets. The posts are driven in the ground usually 100 ft. from the center of the traveled road and can be set in place before frost penetrates the ground to any appreciable depth. It is usually desirable to delay mounting the fencing on the posts until they are well frozen in, otherwise a strong wind may wreck the whole section of fencing. Unquestionably money spent on snow-fencing is a good investment because the cost of plowing a road which passes through a section protected by portable fencing, or by standing timber, is usually cut down by at least one-half as compared to that in unprotected areas. However, most of us are able to buy only a moderate amount of fencing each year and spread it over a few of the worst places.

As time goes on it is possible that a more permanent type of protection will be considered. It usually costs up to 5 cents per foot of fence per year for erection, taking down, storing and repair, which amounts to over $250 per mile. This is an annual charge which, if capitalized, would justify a considerable outlay for permanent protection. Such permanent work could take the form of planting hedges together with the purchase of additional width of right-of-way where required.

Trucks for Snow Plowing.—As to snow-plowing there is still a wide variety of equipment to choose from, but practice is becoming more standardized each year in the use of plows mounted on trucks for handling the greater part of the work. Trucks have two advantages; they are speedy in operation and they have a wider range of uses during the summer construction season than almost any other kind of equipment. Ordinary dump trucks with dual rear wheels in sizes from 3½ tons up are very satisfactory if used with the proper size and type of plow. Trucks with two driving axles can handle heavier equipment. In a number of counties, trucks of the four-wheel drive type are commonly used with large plows. During the present winter we have been trying out a six-wheeler with very good results. This truck has two rear-driving axles and dual wheels. This gives ten tires on the road, eight of which are driving tires and as a result we have excellent traction at all times without using chains.

The first opening of a road after a storm can usually be carried out by a truck-plow of the V and wing type, or by a one-way blade plow with or without wings. Personally I prefer that the wings be used as little as possible in the early stages because they usually throw up a high bank at the side of the road which encourages drifting snow to lodge at a later date. The use of the V alone or of the one-way plow (modified blade) allows of a higher speed and often enables the operator to throw a lot of snow almost to the fences.

Preparing for Next Storm Is Important.—Later operations in widening out the road usually require the use of a wing, but here again there should be some provision for raising and lowering both ends of the wing by a substantial amount so that it can be worked at varying heights. By doing this it can cut off and level back the tops of high banks which may have been formed by earlier trips. This is most important as the preparation of the road to receive the next storm is fully as important as is opening the road for traffic. For this reason some of the most valuable work done by the plow may be carried out during quiet periods between storms. Naturally a road with a wide grade is particularly adapted to this kind of work. The most difficult road of all to handle in winter is a narrow unimproved road with little or no shoulder.

The Public Is Informed of Road Conditions.—There are a number of minor points in winter work which require careful attention. One of these is some arrangement to supply accurate and up-to-date information regarding the condition of any given road. Arrangements can be made to phone in to the office from outlying points so that the traveling public may know how far the road is open and to what extent it is fit for travel. This kind of service is fully appreciated by those who must use the roads in winter.

Crews Must Know the Country.—The public must be protected in every way possible when snow clearing machinery is working. Colored lights on the truck, some arrangement for flood-lighting an extended wing and distinctive painting of plows are all desirable. Two shifts of drivers may be necessary to operate the truck for long hours and the driver or the man who rides in the cab with him should be perfectly familiar with every feature of the landscape. We find it best to utilize the foreman or patrol man in charge of any given district who goes out with the driver and directs the operation of the plow.

Comments on Equipment.—The servicing of trucks or plows is most important. As an example one of the commonest breaks is in the rear axle of the truck. Carrying a few spare axles in stock may save an ex-

pensive delay. In the case of plows the commonest requirement is a supply of spare cutting edges.

Crawler type tractor plows if available can be used profitably for short stretches of main road, for village work, cleaning up intersections and cutting down high banks, but are not commonly used for any extensive work owing to their slower rate of travel. They have a certain disadvantage when used early in the season in that they tend to break up the thin crust of snow left at the side of the road to accommodate sleigh traffic.

Rotary plows are specialized equipment beyond the reach of most of us and of use only under abnormal conditions. If funds were available for the purchase of a rotary plow, I would prefer to use them to buy an equivalent value in ordinary trucks with V or blade plows which can be operated at a much higher speed and which would have a wider range of usefulness throughout the year.

Costs of Snow Removal and Protection.—Unit costs on winter road work in various districts should be compared only after the variations in climatic conditions are taken into account and also the extent of the services rendered. Accompanying this paper is a chart showing the average cost per mile for winter roads in the Ottawa district which are controlled by the Ottawa Suburban Roads Commission. This covers the 8-year period from 1927 to 1934 and the amounts shown include not only the cost of plowing but cover the supply and handling of snow fences, a considerable amount of shoveling, opening up drains and culverts to prevent spring floods and at times some scarifying and cutting out ice ruts. They do not, however, include the cost of any sanding or other protection work on slippery surfaces.

The figures show a minimum cost per mile in 1932 of $51 rising to a maximum of $137 in 1934. In any one year the actual cost of plowing has varied from 30 per cent to 53 per cent of the above figure.

DISCUSSION BY MR. WEIR

This paper has different angles of interest for the different sections of the province. Mr. Hay, in the Ottawa district, has much more snow to contend with than we have in the Niagara Peninsula. We have, on account of the Niagara Escapement running through the county, a large number of long and comparatively steep hills which, in weather that is alternately freezing and thawing, require daily supervision as to sanding. Ice conditions have been worse this year than usual.

Caring for Ice on Hills.—The organization for ice conditions must be very mobile or else be located at each individual hill ready for action should dangerous conditions develop suddenly. We use both methods. Our main organization is centrally located and is equipped with trucks, stone chips and calcium chloride. They have also stock piles of stone and calcium chloride ready mixed at strategic points. This organization consisting of two trucks and four or five men are ready to go out as soon as danger develops and often they can anticipate a dangerous condition and take care of it. The stone chips are spread by hand from the rear of a truck. The Department of Highways have developed a spreader which works well, but I notice they spread by hand about as much as they use the spreader.

On some hills we have sand barrels spaced about 100 ft. to 150 ft. apart and a man living close at hand spreads the sand from these barrels when conditions require it. Calcium chloride or salt is mixed with the sand about 35 lbs. to the yard. The same amount is used with the stone chips.

Approaches to railway crossings and sharp curves are taken care of by the truck gangs. These particular points are often bad places for accidents.

We prefer stone chips to sand as they last longer and grip the tire better. They are also easier for us to obtain. We have no gravel pits or sand pits; if we had them we would probably use sand instead. I would say that the material used depends largely on its availability. Salt is used by the Department of Highways in our district in place of calcium chloride and does as good a job of preventing freezing as the calcium chloride. It has the additional advantage of being cheaper. I have been asked as to damage done by calcium chloride or salt to the pavement. I cannot see that either one is injurious, as it is washed off the road when the ice melts, anyway.

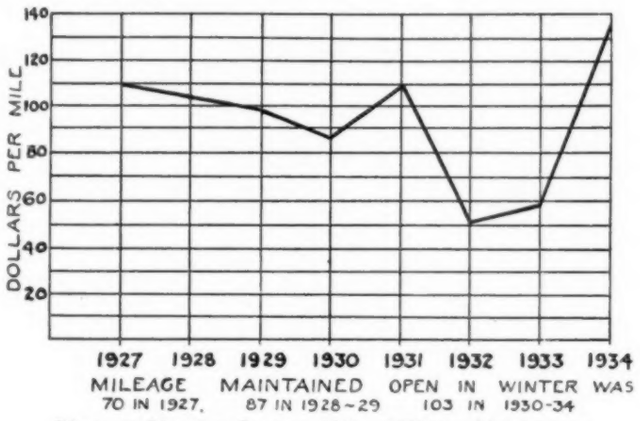

Diagram Showing Cost per Mile of Winter Maintenance

We have not attempted to sand the straight stretches of our roads. The Department of Highways have sanded many miles this winter and I have heard many favorable comments on it from people who have driven in New York State and on this side also. The state of New York does not attempt to sand the roads except at intersections, railway crossings and bad hills. With the object lesson of the department before us, we may in a few years find ourselves compelled to sand all our roads when they become very slippery. Should roads be made safe for normal driving after a reasonable length of time? Twice this winter, for over a week at a time, our roads were very slippery and driving conditions were hazardous. I am not advocating sanding roads, as I have enough troubles without that, and every dollar used on ice is one dollar less to use in improving the roads in summer.

Summer Work Which Helps in Winter.—There are other ways of making roads safer in winter and Mr. Hay has touched on this when he mentioned the building of wider shoulders and flatter ditches, cutting brush and weeds and eliminating objects which collect snow, such as rail and stump fences. I might mention other safeguards. Many of us have not enough money to build wide grades and long culverts at once, but we are getting them gradually. For narrow culverts and bridges, black and white markers at the four corners as a guide to drivers as well as snow-plow operators, adequate guard rails at dangerous spots along deep ditches and sharp turns are useful. Building up the edges of the road so that the road has no excessive crown as highly-crowned roads are slippery in frosty weather.

Large Stone Chips Recommended.—In surface treating a road I have for a long time advocated the use of a larger stone chip than the ⅜-in. chip in common use, and the use of lots of stone for cover at least 20 lbs.

per sq. yd. with a minimum quantity of bituminous material. This makes a stone surface instead of a bitumen surface. This reduces the slippery condition in frosty weather.

Snow Plowing in Lincoln County.—In Lincoln County we have two snow plows: one is a Sargent V-type plow on a FWD truck which will take care of any storm we get in our district, and the other is a straight-blade plow on a lighter truck which is faster and can be removed in about 20 minutes, allowing the truck to be used for other purposes. I think Mr. Hay's suggestion, that it is better to have a number of smaller plows rather than one high-priced plow which at best is not fast enough to cover the whole area quickly, is a good one. His recommendation as to leveling back the banks in preparation for the next blow is good also, and, as he says, can be carried out during quiet periods between storms. Without this cleaning up, the road soon fills in again and is much harder to clear the second time. Our costs per mile of plowing naturally do not come anywhere near Mr. Hay's. Including depreciation and interest, our costs last year ran close to $24 per mile, which included some sanding. This year to date costs have been lower, but the sanding costs have increased.

Considerations on Fencing.—Snow fence has been covered very well by Mr. Hay and, as he says, it is a good investment. His recommendations as to permanent protection against drifting might well be considered in localities where it could be carried out. In parts of our district it might interfere with fruit growers and the purchase of additional right-of-way is an expensive matter with which to deal.

In conclusion it may be said that clearing roads is an expensive job and that the money is wasted as far as the roads go. I am not so sure of that statement. Where roads are kept clear of snow the frost comes out of the road evenly and the road is not kept wet and spongy in spots for long periods. Anyway, in our part of the province, the farmers and truckers demand this service and we would be in a very uncomfortable position if we did not provide it.

A Road Commissioner Tells of His Fight with Snow

A little story of winter maintenance, with just a touch of the dramatic, is contained in a letter from a New England road commissioner to a manufacturer, which came recently into the hands of the editor of ROADS AND STREETS. While the editor is not at liberty to give the names of the correspondents or of the equipment mentioned, the account was so interesting that he quotes it here exactly as it was written except for a few deletions of parts which might serve to identify it.

"Owing to the fact that I am not much of a story teller, I am sending you some pictures that I think are pretty good.

"This winter has been very cold. The thermometer has registered from 20 to 62 degrees below zero. We had been using a tractor that had been in service for four years and we couldn't keep up with our work, our roads became very bad, the shoulders were high and frozen, and our roads were narrow. We called a special town meeting to see about buying a new tractor and voted to buy one. It was left with the selectmen and myself to decide what kind we should buy. We decided on a ———— with a ———— plow. It was delivered here Sunday, January 28th, and on Monday we got a storm with a high wind that filled our roads full pretty much over the town. We started the plow and ran it 129 hours without a stop, except to put in gas and oil. When the tractor got back to the garage we tightened every nut that was loose, changed the oil in the crankcase, and greased the machine all over. The week of February 11th to 17th we did a little side breaking. We burned out a connecting rod Saturday morning, due to a small oil pipe's being broken off near the oil pump.

What the Commissioner and His Equipment Were Up Against

"I called ———— Company, where we bought the tractor and they started for this town with a new rod, a distance of 96 miles. About the time they left ——— it started to snow and blow again; they got within eight miles of here and we had to go on snow shoes to meet them. We finally got the tractor running Sunday afternoon, February 19th. Our roads were all full again. We plowed steadily from February 19th to March 3rd, day and night, with the thermometer registering about 30 degree below zero and drifts from 3 to 9 feet high, hard enough to hold a pair of horses.

"We only stopped long enough to add gas and oil and grease the machine. I guess we did eat somewhere once or twice.

"We were one of the first towns to plow roads. We have only one piece of equipment and most of the other towns have two or three.

"We break about 80 miles of road. I have served in the capacity of Road Commissioner for 6 years, and was one of the committee that bought the ———— (the old tractor which was displaced), which gave us very good service."

The Road and the War

Ethiopia is perhaps the one spot on earth today which may be congratulated on its lack of roads. Ten miles of paved streets in the capital, about 80 miles of water-bound macadam scattered in two or three parts, some 400 miles of improved earth road good in dry weather but not in wet, and approximately 500 miles of unimproved earth—a total of less than 1,000 miles—constitute the entire road system of a country of 350,000 square miles area. There is, of course, in addition, the railway from French Somaliland to Addis Adaba; but away from these lines, transportation is merely by trail or caravan route.

Under such conditions, Italy, with its mechanized army, must proceed slowly, while the natives will have the best possible opportunity for defense with their scant and largely primitive weapons.

Ethiopian conditions, however, are the antithesis of conditions in Europe and America. Here, where mechanical development has been greatest and where an already large supply of army machines can be rapidly expanded, the highway system is a vital link in the defense, and every road a help.

It is many years since military highways have attracted any public interest, but at this moment it is well to remember that when we build a road for commerce or for pleasure we build also for the defense of our homes against attack from which even our position as the most peace-loving of great nations cannot insure immunity.

EDITORIALS

In Planning, Consider All Things

City planning and regional planning, still infant sciences, occasionally clash, as infants will. They are brothers whose interests harmonize in part only. The welfare of the smaller community, the city or town, is not always identical with the welfare of the larger community, the region; and the thing that is desirable for the city as a whole may be bad for some of its parts.

It is easy to assume in such cases that the smaller should yield, but that assumption is a bit too simple. A benefit to the region may be secured at too great a sacrifice to the town.

Among the specific objectives of city planning, in its general purpose of civic betterment, the conservation of real estate values has always been recognized as one of the foremost. To this end cities are zoned and streets planned to carry appropriate traffic, business districts are protected from the encroachments of damaging industries, and heavy traffic is kept from residential areas.

Now, the main conflict between town and region arises at this last point. Regional planning, the younger if not the smaller brother, calls for highways between strategic points or centers, and calls for them usually by the most direct routes. Also it projects scenic highways from populous centers along such routes of beauty as may be available. Unquesionably worthy objects!

But it sometimes happens that the most direct route lies through an established residential district, a district entitled to protection from excessive traffic—perhaps, even, a district settled by people definitely seeking quiet. Or it may be that a handsome residential area appeals to the regional planners as a spectacle for sight-seers. Must the home-owner in such case yield his interest (we are tempted to say his "right") to the motorist from the near-by city?

Sometimes, unfortunately for him, Yes. Where the necessity is great and no practical alternative route is available, it is stubborn foolishness to demand that the right of the home prevail: the loss is a hardship inevitable in a changing order. But without this absolute necessity, it is neither wise, just, nor economically sound to force an injurious plan on a local community.

Unfortunately, some planners have not the breadth of view to see this. They regret any injury, but they feel an unanswerable logic in putting the good of the many ahead of the few. They see the quantitative but not the qualitative relation. They measure one home-owner against a thousand motorists without considering that while the one has a great part of life's interest at stake, the thousand are concerned only with a few minutes of time and a bit of gasoline.

Before acting, a good planning commissioner will consider *all* the results of what he is about to do. Even when economic analysis shows values accruing to the public in excess of damage done to individuals, there remains the home-owner's love for his property. Laugh at it and call it sentimental if you wish, or rule it out as being incommensurable with economic values, it nonetheless remains—a very *real* value which cannot in justice be ignored.

This is not an argument against planning—either city or regional: we need far more of both. But let our planning be broad-minded enough to go beyond the axiom that the shortest distance between two points is a straight line.

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A Proposal for More Use of Daylight

On Sunday, September 29, Chicago and certain other central western cities changed from their summer "daylight saving" to Central Standard Time. This they will carry until the last Sunday in April, when presumably they will again go on summer schedule. Daylight saving has become practically an institution in these communities. It meets opposition and complaint, to be sure, but the great majority favor it for reasons not requiring repetition.

Now comes a new suggestion, and one, we think, worthy of consideration, not only in Chicago, but throughout the country generally. Chicago school authorities and certain others recommend that daylight saving be dropped and that the city instead be placed permanently on the Eastern Standard Time basis. Summer time conditions would then be the same as under the daylight saving system, which has already proved its merits, while each fall and winter day would have one hour more of daylight at its close and one less at its beginning.

There can be little doubt as to the relative value of these two hours: the one gained at the end of the day would be used many times more, and to vastly greater advantage, than the one lost at the start, and there would be a saving of one hour of lighting expense at the busiest part of the day against an hour's extra lighting at the quietest.

That such a change would be in line with past history is probably not generally realized, but the fact is that not so many years ago Pittsburgh was in the line of change from Eastern to Central Time; later the change was shifted to central Ohio; still later Detroit and certain other Michigan cities went on Eastern time. So, it could hardly be considered revolutionary for Chicago to follow a like course, although there would certainly be opposition from that substantial part of the community to whom all change is anathema, as well as from the minority who would suffer actual inconvenience.

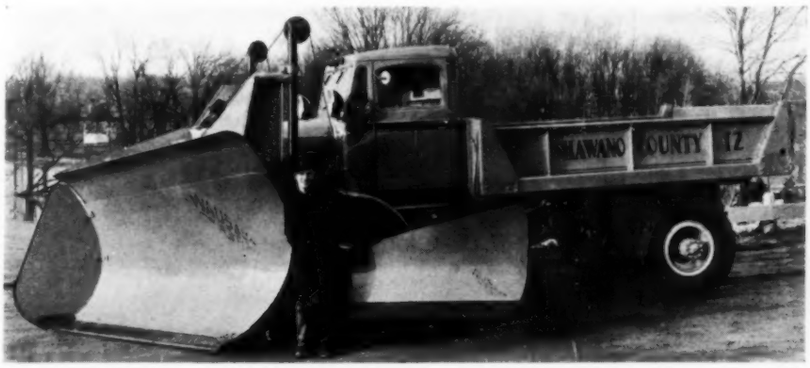
The scientifically inclined while approving the better use of the daylight hour, may protest that a more sensible procedure would be to keep standard time on its original basis and then move our affairs ahead an hour, so that school would begin at eight instead of nine, offices open at seven thirty instead of eight thirty, and close at four instead of five, baseball begin at one thirty, and so on. Such a program has much in its favor, but we doubt its acceptance by the public; habits and customs are too ingrained, and a change in the school, business, or dinner hour becomes a more serious matter than a change in the entire time system. For the present, the Chicago proposal seems to afford the more practical working basis.

NEW EQUIPMENT AND MATERIALS

FWD Snow Removal Line Features Safety and Dependability

The Four Wheel Drive Auto Co., Clintonville, Wis., is introducing an improved and superior line of snow removal trucks for the winter of 1935-36, according to the recent announcement by Walter A. Olen, president and general manager.

Many new improvements have been made in the various models to increase their safety and dependability. Primary of these are the safety measures taken to prevent the presence of carbon monoxide in the cabs of the trucks during operation.



View of 10-Ton FWD Snow Removal Truck Used by Shawano County Highway Department, Wisconsin, for Breaking Open Heavy Drifts.

The FWD Company is employing a threefold line of defense against the carbon monoxide menace.

Tight exhaust lines are assured through the use of a three-piece manifold with expansion joints between the middle and two end sections. The joints compensate for the differences in expansion between the manifold and cylinder block which occur alternately each time the motor heats up and cools off. The compensation for the expansion differences lessens the high strains built up in the manifold and manifold gaskets which cause them to warp or crack, allowing exhaust gases to leak out. A change has also been made in the joint between the manifold and exhaust pipe to eliminate gas leaks at this point.

The next preventative measure is a thorough check and adjustment of the ignition and carburetion systems of each truck in order to attain the proper combustion efficiency of the motor.

The third step in the precaution against carbon monoxide is the installation of gas tight cabs and the thorough check of each with a continuous carbon monoxide detector. All of the new cabs are closed tightly around the pedal openings, control set and holes in the dash where the wiring enters. The toe boards are reinforced with steel plates to prevent breaking and splitting after long time service.

All of the models are now equipped with aluminum pistons. This change increases the governed speed 250 r.p.m. or about 12 per cent with a corresponding increase in speed and horsepower.

The frames of several models have been strengthened to increase their capacity for standing the thrust of bucking heavy snow. Drop frames of 7⅞ in. width have been adopted as standard equipment on the HS series, 1½ ton trucks. The new frames are 35.5 per cent stronger and 5 in. lower than the old type. The H6, HH6 and the Maintainer series now have 7 in. frames about 25 per cent stronger than formerly used.

The Utility series in the 3½ 5-ton range have received special attention in increased efficiency for snow removal work. The front axle ball and socket and the front axle shaft cage ring have been increased in size. Axle ring gears are now fastened to the differential housing by twice the number of bolts thus materially increasing the strength of this assembly. Other improvements in this series include: four wheel booster operated hydraulic brakes; larger propeller shaft joints; thermostatic water flow controls; and new square type of rear axle housings which make possible the use of the same rear axle assembly for both single and dual tires.

The M series now includes the M-10, 10 ton truck, as a standard model. The M-10, largest four wheel truck in the FWD line, has a 198 hp. motor, oversize transmission and axle shafts which make this unit especially adaptable for the heaviest kinds of snow removal work.

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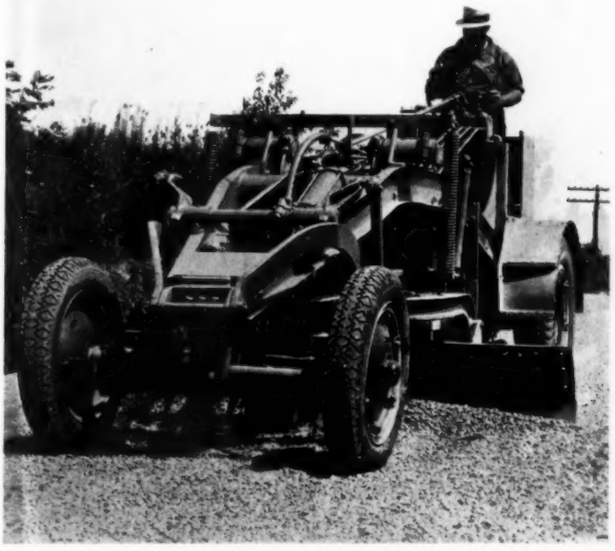
New Patrol Motor Grader

A new light motor patrol grader has been brought out by the Galion Iron Works & Mfg. Co., Galion, O. Incorporated in its design are all the very latest developments and improvements found in the heavier Galion motor patrol graders. It has full hydraulic operation for raising and lowering the blade and scarifier. The hydraulic pump which furnishes power to the operating cylinders is located at the rear of the grader and is completely shielded and protected, yet quickly accessible for inspection and repair. It is driven by a standard power take-off from the tractor motor.

The operator is located at the rear of the machine. Sitting on an upholstered seat within the all-steel compartment, he has a good view of the contour of the work to be done ahead as well as the work which the blade and scarifier are doing. Cab and curtains or fully enclosed cab can be furnished as optional equipment. All controls are within easy reach of the operator.

The frame, weighing 17.25 lb. per foot, is amply braced and reinforced with torque tubes to eliminate all weave, even under the severest operating conditions. The circle is built of railroad rail, well braced and reinforced so that chattering is completely eliminated. The hang rods have ball and socket joints which can be refitted to eliminate lost motion when wear occurs.

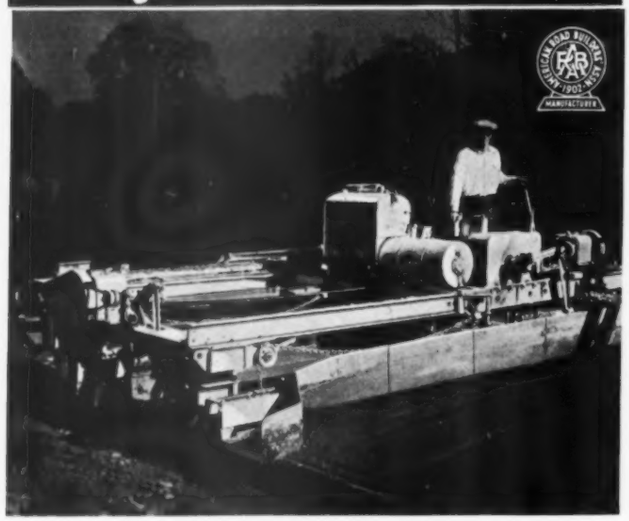


Galion Junior Motor Patrol Grader

An 8 ft. moldboard and blade is regular equipment. However, a 10 ft. moldboard and blade can be substituted at additional cost. The steering gear is a Ross cam and lever heavy duty model, completely enclosed and dust proof.

Power is furnished by a McCormick-Deering 1-12 Industrial power unit which develops 21 hp. at 1800 r.p.m. Three forward speeds are available, with throttle control.

BLAW-KNOX CONSTRUCTION EQUIPMENT



ROAD FINISHER

Yesterday's equipment cannot compete to build today's roads —at a profit. Blaw-Knox is ready with this complete line of thoroughly modernized construction equipment—new developments ready to do jobs faster, cheaper and better. Buy new, buy now—insure your profits.

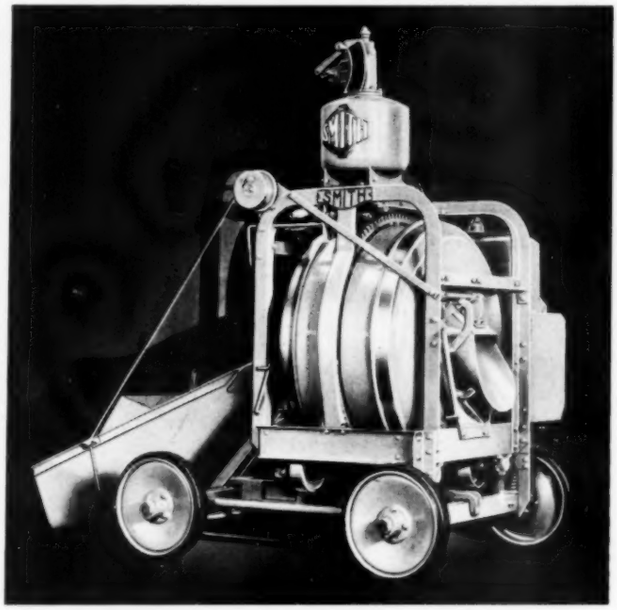
BLAW-KNOX CONSTRUCTION EQUIPMENT ALSO INCLUDES Steel Forms for general Concrete Construction, Street and Sidewalk Forms, Truck Turntables, Cementanks, Tamping Rollers, Portable Asphalt Plants, Central Mixing Plants, Ready Mixed Concrete Plants, Steel Buildings, Steel Grating, Batcherplants, Bulk Cement Plants, Automatic Batchers, Trukmixers, Bulldozers, Dirtmovers, Clamshell Buckets, Road Forms, Gas Electric Road Finishers.

BLAW-KNOX COMPANY
2003 Farmers Bank Building, Pittsburgh, Pa.
Offices and Representatives in Principal Cities

New 10-S Mixer

The T. L. Smith Co., Milwaukee, Wis., concrete mixer manufacturer since 1900, has recently added to its line a four wheel end discharge model in the 10-S size. The new machine, unsually compact and light in weight, is claimed to combine the advantages of the two wheel end discharge model with four wheel truck stability. It is only 6½ ft. wide.

The unique truck design of this new 10-S machine provides for a 5-ft. wheel base. Automotive type steering axle, 3-point suspension with spring mounting, and balanced weight, permit fast towing speeds. Engine mounting on the right hand side avoids



New Smith 10-S Mixer

any overhang on the traffic side. The telescopic tow bar folds back while mixer is in use.

Other construction features include the Smith end-to-center mixing action, enclosed gear reduction running in oil, multiple V-belt drive, automatic skip vibrator, anti-friction bearings throughout, and one man end control. A new vertical syphon type water measuring tank with calibrated gauge is accurate to-the-ounce. Measurements are not affected by variations in water pressure.

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New Cletrac with Sargent Snow Plow for Sidewalk Work

Model EN Cletrac, recent addition to the line of the Cleveland Tractor Co., Cleveland, Ohio, is designed especially to meet the requirements of sidewalk snow plowing.

Model EN Cletrac with Sargent Sidewalk Snow Plow

The overall length is 105½ inches; overall width is 41¼ inches; overall height is 55½ inches; center to center of the tracks is 30⅞ inches; and the turning radius is 4½ feet. The weight is 4870 pounds.

The tractor has a drawbar horsepower of 22.14 and belt horsepower 26.9.

There are four lower track wheel assemblies on each side with continuous positive lubrication. The track is 8 inches wide, comprised of one piece, drop forged track shoes. The length on the ground of each track is 56 inches. The total tractive surface is 896 square inches.

The pulley diameter is 10½ inches; face is 8½ inches, and the pulley speed is 2985 feet per minute at 1085 r.p.m. The rear power reduction shaft (A. S. A. E. Standard 1⅜-6B Spline) speed is 550 r.p.m.

The transmission is of the selective type with speeds as follows: Low—2⅛ m.p.h.; intermediate—2.75 m.p.h.; high—4 m p.h.; reverse—1⅝ m.p.h., at a governed engine speed of 1300 r.p.m. The heat-treated, alloy steel gears and shafts in the transmission operate on heavy duty ball bearings. Lubrication is positive, through a plunger pump.

The tractor is shown here, equipped with a Sargent sidewalk plow, being operated over a step from sidewalk to roadway level.

▼

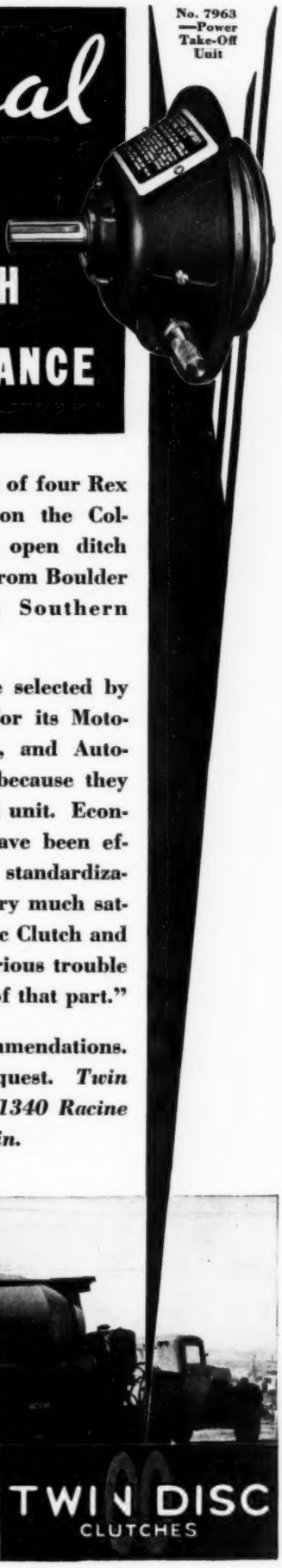
Good Roads Champion Snow Plows New Models

For the winter season of 1935-1936 the Good Roads Machinery Corporation of Kennett Square, Pennsylvania, has developed many improvements to its line of highway snow plows, and has added several new models in one-way and "V" types. Two of these, Models 36 and 40, are illustrated herewith. Plows are furnished in types and sizes suitable for use with all standard trucks of from one and one-half tons capacity to the heaviest built. Among the features characterizing these plows is the safety automatic blade release mechanism, safeguarding men and equipment; hydraulic lifting devices fully adjustable for attachment to all trucks; quick adjusting blade feature, for changing the vertical pitch and cutting angle of the blade to best cope with wet, medium or dry snow conditions; improved method of semicircle attachment to moldboard, with varying adjustments available; Plows supported upon full-swivelling, roller-bearing, spring-mounted caster wheels with alemite lubrication fittings. The casters are adjustable for height to compensate for any wear on the cutting edge, and this same feature is utilized to set the blade

Good Roads Champion Model 36 Plow with Adjustable High Lift Wing for 5 to 7 Ton Trucks

Good Roads Champion Model 40 One-Way Plow equipped with Snow Shield and Landside

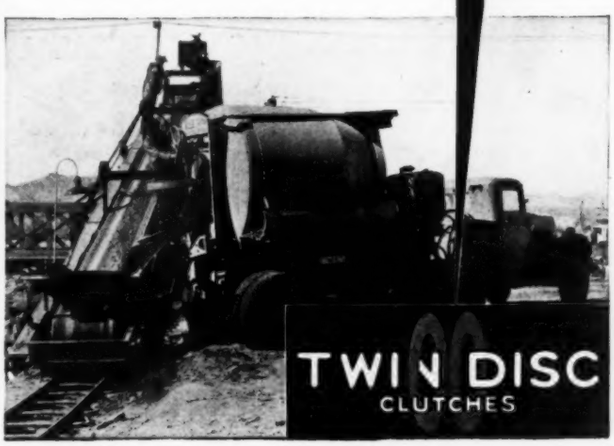
A real test OF CLUTCH PERFORMANCE



Here is one of a battery of four Rex Moto-Mixers at work on the Colorado Aqueduct — an open ditch which will carry water from Boulder Dam 242 miles into Southern California.

Twin Disc Clutches are selected by Chain Belt Company for its Moto-Mixers, Moto-Agitators, and Automotive Road Pumps "because they are a good standardized unit. Economies in production have been effected because of this standardization. We have been very much satisfied with the Twin Disc Clutch and have experienced no serious trouble due to any breakdown of that part."

Write for specific recommendations. Engineering data on request. *Twin Disc Clutch Company, 1340 Racine Street, Racine, Wisconsin.*



ACCURACY for SPREADING SURFACE MATERIALS

THE Buckeye Surface Material SPREADER

Lays down specified amounts of material to a true line and uniform depth.

Cost savings that really pay are gained in both time and material. Measured volumes are spread exactly where wanted. It operates equally efficiently in forward or reverse motion, and varying speeds do not affect the accuracy of spread. Efficient for new work, resurfacing or patching—it works close to guard rail or obstructions—spreads full width of the machine. Write today for complete bulletin and prices.

The Buckeye Traction Ditcher Co. — Findlay, Ohio

LOW COST SNOW REMOVAL

The Silver King Snow Plow is a substantial and highly efficient snow removal tool. It pushes the snow from the rear axle of the tractor instead of from the front end only. Heavy high carbon steel push bars extend back under the tractor and connect close to the point of power which eliminates the tendency of the tractor to run sidewise under difficult conditions. For low cost snow removal, you can't beat the Silver King. SEND FOR ILLUSTRATED BULLETIN.

THE FATE-ROOT-HEATH CO.
PLYMOUTH, OHIO

WITH THE SILVER KING

at any desired height within limits. The method of connecting to trucks provides for free oscillation of the plow, thus allowing the blade to conform to the contour of the road.

The manufacturers have just issued Catalog and Handbook No. 100, an interesting volume describing in detail the complete line of their snow plows and containing much information of interest to snow fighters.

▼

WITH THE MANUFACTURERS

Kentucky Rock Asphalt Institute Organized

George Rapp, Vice-President of the Ohio Valley Rock Asphalt Co., was elected to the Presidency of the newly formed Kentucky Rock Asphalt Institute at its organization meeting held in the Institute offices, Marion E. Taylor Building, Louisville, Ky., on Sept. 18. Mr. Rapp is a graduate Civil Engineer of Cornell University, and formerly was Maintenance of Way Engineer for the Pennsylvania R. R. Co. He has been connected with the Ohio Valley Rock Asphalt Co. since 1922.

Walter Areta, Vice-President of the Natural Rock Asphalt Corporation, will serve as Vice-President of the Institute, and W. N. Bosler, Assistant Sales Manager of the Kentucky Rock Asphalt Co., was elected as Secretary and Treasurer. The following will serve as the first Board of Directors: Rodman Wiley, Sales Manager of the Kentucky Rock Asphalt Co., Phil McGovern, Sales Manager of the Ohio Valley Rock Asphalt Co., and G. C. Appleton, Chief Engineer of the Natural Rock Asphalt Corporation. A. H. Hinkle, former Deputy Highway Commissioner of Ohio and later Superintendent of Maintenance for the Indiana State Highway Commission, was appointed Executive Director.

Mr. Hinkle, who will head the Institute, is a civil engineer, graduate of Ohio State University, and has had a wide experience in engineering practice, particularly in highway construction. Major assignments in this connection include 8 years' experience as Deputy Highway Commissioner of Ohio and 14 years' service as Superintendent of Maintenance of the Indiana State Highway Commission. Mr. Hinkle was appointed State Engineer for the Public Works Administration of Indiana in August, 1933, resigning that post in May 1934 to accept the position of Research Engineer with the Kentucky Rock Asphalt Co. Discoveries of great practical value in this field led to the organization of the Kentucky Rock Asphalt Institute with Mr. Hinkle as Director, sponsored by all of the rock asphalt producing companies in that state.

A. H. Hinkle

The purpose of the Institute will be to place at the command of officials and others definite and reliable information and cooperation as to where, when and how both natural and processed Kentucky rock asphalt can be used to economical advantage in the surfacing of streets, highways, park roads, private drive-

ways, tennis courts, drill halls and other places where a smooth, resilient, non-skid surface is desired.

Experiments in the last two years have resulted in perfected methods for the processing of the lean rock (containing 3 per cent to 6 per cent natural asphalt) which heretofore has been wasted in the production of natural Kentucky rock asphalt. The Kentucky companies are now marketing the material "processed" both by the hot and cold methods. The use of the unique sandstone aggregate in the "processed" material produces a pavement possessing the non-skid qualities of the natural Kentucky rock asphalt, it is said. The offices and laboratories of the Kentucky Rock Asphalt Institute will be located in the Marion E. Taylor Bldg., in Louisville.

▼

Republic Steel Awarded First Prize N.I.A.A. Conference

For the most outstanding advertising campaign of the year in the field of metals Republic Steel Corporation was awarded first prize by judges at the 13th Annual Conference of the National Industrial Advertisers' Association held at Pittsburgh on Sept. 18, 19 and 20.

S. A. Knisely, Advertising and Sales Promotion Manager of Republic, states that the prize-winning campaign was created and placed by G. M. Basford Co., Industrial advertising agency, with offices in New York and Pittsburgh.

The convention program included an address by C. W. Ruth, Assistant Advertising Manager of Republic Steel Corporation on the subject "Shall Exhibits at Shows Be Used?" Ruth's talk was one of ten in a symposium on the general topic "How to Get the Most Out of the Selling Tools at Our Command."

▼

Link-Belt Personnel Changes—Announcement is made by Link-Belt Co., Philadelphia, that T. Frank Webster, of the Link-Belt Co., Philadelphia office, has been appointed resident manager of the company's Boston office, succeeding Horace Goldstein, who has been assigned to engineering sales work at the Philadelphia office. Mr. Goldstein is well acquainted in Philadelphia territory and was formerly attached to the company's New York office. Mr. Webster formerly was resident manager of Pittsburgh.

▼

Chiles Now Assistant Manager of Sales of Bar Division, Republic Steel Corp.

Frank F. Chiles, formerly Manager of Sales of the Bar Division of Corrigan, McKinney Steel Co., has been appointed Assistant Manager of Sales of the Bar Division, Republic Steel Corp., with headquarters at Youngstown, Ohio, according to an announcement by N. J. Clarke, Vice-President in Charge of Sales for Republic. The appointment is effective immediately. In his new capacity, Mr. Chiles will assist W. F. Vosmer in supervising the sales of all carbon semi-finished steel bars, shapes and plates produced by Republic.

▼

Western Cataphote Co., National Distributors for Tyton Guard Rail

Western Cataphote Company, Toledo, O., state that they have been appointed national distributors for Tyton Guard Rail and Berloy Plate Guard Rail by the Berger Manufacturing Company, division of Republic Steel Corporation of Canton, O.

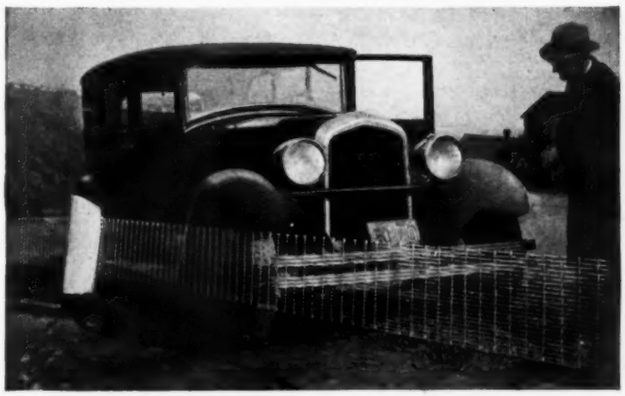
▼

Inland Steel Acquires Ryerson Co.

At the special stockholders' meeting of Inland Steel Co. on Sept. 20 the plan of reorganization to effectuate the union of the business of Inland Steel Co. with that of Joseph T. Ryerson & Son, Inc., was approved. The charter was amended by increasing the authorized no par value shares from 1,200,000 to 1,600,000, of which 240,000 shares were authorized to be issued for the acquisition of all of the assets, business and good will of the Ryerson company.

Edward L. Ryerson, Jr., Joseph T. Ryerson and Everett D. Graff were added to the board of directors of Inland Steel Co. J. H. Morris was also elected a director. Edward L. Ryerson, Jr., is president and a director of the Ryerson company. He entered its employ in 1909, immediately after finishing college.

WITHOUT KILLING OR MAIMING!!



Like the net that catches the circus performer as he drops from his trapeze, Pittsburgh Safety Highway Guard absorbs the shock of impact as it stops the car at the brink of disaster. Neither car nor guard is much damaged, and occupants are saved from serious injury. • Pittsburgh Safety Highway Guard is a 14" band woven with semi-spring-steel continuous longitudinal wires having tensile strength exceeding 190,000 lbs. per square inch. The slight resiliency of the guard cushions the impact, while its breaking strength of 45 tons is ample to stop the heaviest vehicles.

PITTSBURGH STEEL COMPANY
742 Union Trust Building • Pittsburgh, Pa.

Pittsburgh
Safety Highway Guard

PITTSBURGH STEEL CO. • 742 Union Trust Bldg. • Pittsburgh, Pa.
Gentlemen: I am interested in Pittsburgh Safety Highway Guard.
Please send descriptive literature and specifications.

Name.....
Address.....
Title.....

FOR SNOW REMOVAL . . .

● (Left) Snow-hidden stumps, logs and woods trash are no bar to the LE TOURNEAU ANGLEDOZER shown here clearing a truck logging road.

● (Below) 7,500 feet above sea level this TOURNEAU ANGLEDOZER cuts snow removal costs while keeping open the Placerville-Tahoe highway in California's high Sierras.

The LE TOURNEAU ANGLEDOZER moves both snow and earth quickly and cheaply because of its:

Stout, correctly-curved high bowl—built like a plow moldboard to roll material . . . 39½ to 42 inches high, depending on ANGLEDOZER size.

Trigger-quick mechanical control—no oil to freeze, no waiting for pressure to build up.

High lift—3 to 3½ feet above the ground surface.

Low drop—5 to 6 feet below ground surface.

Ask for data sheet proof of LE TOURNEAU ANGLEDOZER performance.

R. G. LE TOURNEAU, INC.

PEORIA, ILLINOIS **STOCKTON, CALIFORNIA**

Cable Address: "Bobletorno"

Manufacturers of: ANGLEDOZERS, BULLDOZERS, DERRICKS, BUGGIES, CARRYALL SCRAPERS, ROOTERS, TRAILERS, POWER CONTROL UNITS, SHEEP'S FOOT ROLLERS.

LE TOURNEAU ANGLEDOZER

TRADE MARK

After service in all departments of the company's business, he became vice president in charge of operations, and in 1929 was elected president. Joseph T. Ryerson is a director of the Ryerson company and was its president until 1929. Starting his business career in the employ of the American Sheet Steel Co. at Vandergrift, Pa., where he gained considerable steel mill experience, he became associated with the Ryerson company in 1902. Everett D. Graff is first vice-president and a director of the Ryerson company. He began in the company's mailing room in 1906 and served in many departments.

▼

Hillsman Now Sales Manager for "Ace" Joint

Mr. George E. Hillsman has recently been appointed sales manager for the American Concrete Expansion Joint Co. of 221 N. La Salle St., Chicago, Ill., manufacturers of a copper-sealed expansion joint for concrete roads, known to the trade as "Ace Joints." These joints have been widely accepted by the State Highway Departments throughout the country for concrete road construction, and in addition have been extensively used in swimming pools and large watertight concrete structures.

In the midwest section of the country centering around Indiana, Illinois and Iowa, Mr. Hillsman has a host of friends in the contracting and road building fields and with the American Concrete Expansion Joint Co. already well established, he feels it will be but a short matter of time till their field of distribution has been extended from coast to coast.

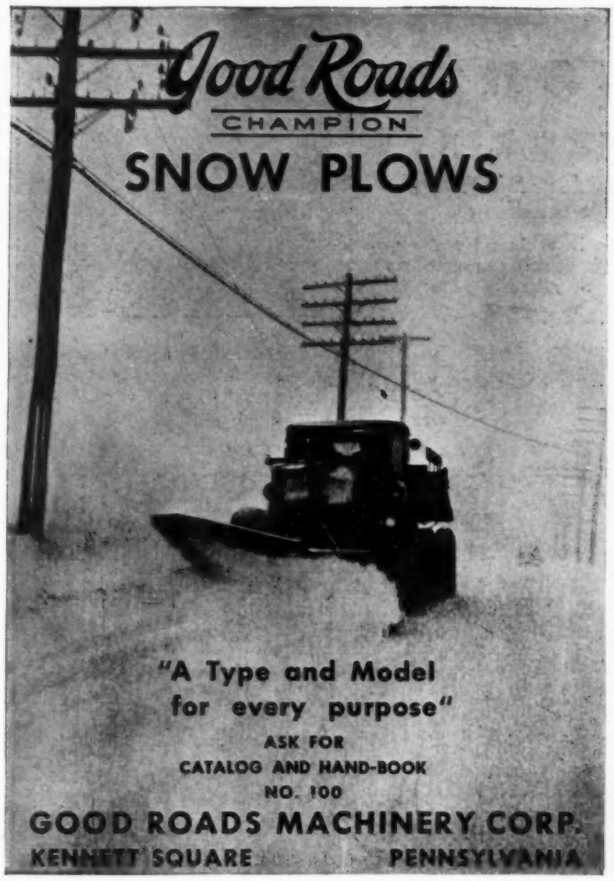
Mr. Hillsman has been identified in the highway construction business for over 25 years, having been president of The G. E. Hillsman Company, and later secretary-treasurer of Lowe Hillsman Company, distributors of construction machinery equipment and supplies with offices in Chicago and Indianapolis. He was a member and director of the Associated Equipment Distributors, a national organization of equipment distributors.

NEW LITERATURE

Underpass Drainage Pumps—How to select pumps for draining underpasses at grade separations is told in a new bulletin entitled "Underpass Drainage Pumps, Bulletin 22" just published by the Chicago Pump Co., 2303 Wolfram St., Chicago, Ill. The booklet contains a great deal of information for highway engineers on solving the drainage problems of underpasses. Complete information on how to determine pump capacities is given. Layouts with dimensions are given for half a dozen different types of installations. This information is essential when the engineer is laying out pump pits and pump houses. Pump dimensions are given. Capacity and discharge head tables are given for all types of underpass drainage pumps. The horsepower motors furnished and the various speeds at which the motors operate are included. Specification forms for different types of underpass drainage pumps are given to aid engineers in writing up their specifications. An automatic alternator shown for duplex sets of underpass drainage pumps will be of special interest to engineers. The alternator automatically transfers the operation from one pump to the other; starts the second pump in case the first pump fails and causes both pumps to operate in the event that the inflow is in excess of the capacity of one pump.

▼

Drag Scrapers, Cableways—A 56-page catalog of Sauerman long range machines has been issued by Sauerman Bros., Inc., 488 South Clinton St., Chicago, Ill. It contains 145 illustrations and is the first catalog to cover the entire line of Sauerman long range machines, previous Sauerman catalogs having been devoted each to a specific type of machine, one catalog dealing only with Drag Scrapers, another with Slackline Cableways, and so on. Complete information is given in this new catalog relative to sizes, capacities, applications, and mechanical details of every type of machine in the Sauerman line.



JAEGER Adjustable SPREADER
BASE
SURFACE
Smoothly Spreads Stone, Macadam and Bituminous—1" to 10" of Loose Material, 8 to 11 Ft. Widths.
Lays low cost roads, faster, smoother and with real savings.
JAEGER
BITUMINOUS PAVER
power-driven, adjustable 9 to 15 ft., does precision job without forms. Write for details.
THE JAEGER MACHINE CO.
223 Dublin Ave., Columbus, Ohio

Electric Tools—The Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill., has just issued a new catalog, No. 32, which illustrates and presents specifications on the entire Thor line of Universal electric tools. In addition to the regular line of tools, this catalog includes the new U-14, the small and light weight portable electric tool. This catalog includes a complete showing of portable drills, screw drivers, hand grinders, bench grinders, nut setters, tappers, saws, and electric hammers.

▼

Lubrication Equipment Catalog—The revised mid-year 1935 Alemite Powergun equipment catalog of the Alemite Corporation, 1874 Diversey Parkway, Chicago, Ill., contains 25 pages in which are presented, in natural colors, all equipment and accessories necessary for every kind of a complete, money-saving lubrication job. Full details and specifications are given, and all prices are quoted.

▼

The Strength of Monolithic Concrete Walls.—A 36-page, illustrated report of an investigation conducted by the Engineering Experiment Station, University of Illinois, in cooperation with The Portland Cement Association, by Frank E. Richart and Nathan M. Newmark. Bulletin No. 277, Engineering Experiment Station. Published by the University of Illinois, Urbana. Price: Forty Cents.

▲

New Bulletin on Welding—An attractive, new 24-page bulletin just published by the Harnischfeger Corporation of Milwaukee, Wis., covers the complete line of P&H-Hansen arc welders from 50 to 800-ampere units as well as welding fixtures and accessories. Copies will be sent upon request to the home office or to any of its branches or agents. Ask for Bulletin HW-4, "Weld It Well."

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF MARCH 3, 1933

Of Roads and Streets, published monthly at Chicago, Illinois, for October 1, 1935.

State of Illinois } ss.
County of Cook }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. S. Gillette, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Roads and Streets and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Gillette Publishing Company, 400 W. Madison St., Chicago, Ill.; Editor, H. P. Gillette, 400 W. Madison St., Chicago, Ill.; Managing Editor, C. T. Murray, 400 W. Madison St., Chicago, Ill.; Business Manager, E. S. Gillette, 400 W. Madison St., Chicago, Ill.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) Gillette Publishing Company, 400 W. Madison St., Chicago, Ill.; H. P. Gillette, 400 W. Madison St., Chicago, Ill.; E. S. Gillette, 400 W. Madison St., Chicago, Ill.; Mrs. R. W. Hume, 303 S. Stone Ave., La Grange, Ill.; Winifred Gillette, 1125 Oak Grove Ave., San Marino, Calif.; Provident Trust Company, 17th and Chestnut Sts., Philadelphia, Pa.; Louise Forsythe, 13 E. Windemere Terrace, Lansdowne, Pa.; La Verne Louer Hellyer, Ambassador Hotel, Chicago, Ill.; L. H. Enslow, 155 E. 44th St., New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

EDWARD S. GILLETTE,
Business Manager.

Sworn to and subscribed before me this 1st day of October, 1935.

[SEAL] KITTIE C. WOULFE, Notary Public.

(My commission expires Feb. 8th, 1938.)

Crescent
Drag Scrapers

Long Range Machines for Digging — Stock-Piling — Rehandling

These powerful scrapers are in a class by themselves for any project of moving materials distances of 200 to 1,000 ft. or more.

Write for Catalog.

Above is shown the special type of Crescent Scraper made for tractor haulage.

SAUERMAN BROS., Inc.
488 S. Clinton St. CHICAGO

Crescent Scrapers show especially low costs in moving gravel from pit or bank to plant.

WOOD HYDRAULIC

BODIES
for tandem axle trucks

Special body for rubbish, dry wrapped garbage, etc. Capacity 4½ cu. yds. with 2 cu. yd. hinged extension sides. Watertight construction, barndoor type tailgate and model F4C hydraulic hoist.

Designed for road construction, Wood W12 heavy duty dump body with F4CA hydraulic hoist mounted on tandem axle 1½-ton truck chassis. The unit has a capacity of 4 cubic yards.

Write for descriptive Bulletins on all types of dump equipment

GAR WOOD INDUSTRIES, INC.
7924 RIOPELLE STREET, DETROIT, MICHIGAN
FACTORY BRANCHES AND DISTRIBUTORS IN 51 CITIES

CHICAGO PUMP CO.

Underpass Drainage Pumps

Electric Motor and Gasoline Engine Driven Centrifugal Pumps

Layouts and Quotations Promptly Furnished

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Pierce Power Rollers
For Road and Street Construction and Repairs

For building and maintaining roads and streets, Pierce Rollers are without an equal. The first cost of the Rollers is low and cost of operating is negligible. Because of weight distribution and roller width, the compression per inch compares favorably with that of heavier rollers. Many Pierce Rollers have been in service eight and nine years without any parts replacements and practically no service expense.

Built in three serviceable models—¾-ton, 1½ - 2 tons, and 3 tons. You save money when you buy Pierce Rollers. Write for information.

The Pierce Governor Company
Anderson, Indiana

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GRAND COULEE
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ROCKY MOUNTAIN NATIONAL PARK
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Standard Asphalt Paving Co. using an Adnun Black Top Paver at Grand Coulee

IT is significant that the contractors on the big jobs of the country involving Black Top road construction are using Adnun Black Top Pavers. Adnun's proved ability in the hands of the leading contractors combined with exclusive Adnun advantages is your assurance of exceptional results with higher profit. May we send you a bulletin?

THE FOOTE COMPANY, INC.
NUNDA, N. Y.
The world's largest exclusive builders of Road Pavers

FOOTE ENGINEERS have kept pace with concrete road problems. The MultiFoote Paver is absolutely up to the minute—the latest thing in concrete pavers. When you are in the market ask about its 10 points of superiority.

ADNUN BLACK TOP PAVER

ROADS AND STREETS

with which is merged Good Roads and Engineering and Contracting.
Covering design, construction and maintenance of
HIGHWAYS, BRIDGES and OVERGRADE CROSSINGS

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